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(ESTABLISHED IN 1832.)

THE OLDEST RAILROAD PAPER IN THE WORLD.

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ANNOUNCEMENT.

WITH the present number, the first of the volume for 1893, the title of the RAILROAD AND ENGINEERING JOURNAL, under which it has been published since 1887—when the old *American Railroad Journal* and *Van Nostrand's Engineering Magazine* were consolidated—is changed to THE AMERICAN ENGINEER AND RAILROAD JOURNAL.

The chief reason for making this change is that the former title is somewhat cumbrous, is lacking in definiteness, and is not easily remembered. It has been found that many persons familiar with the JOURNAL, and even those who are regular readers of the paper, do not readily recall its name, and that it is often difficult to identify it by its title alone. At the time of the consolidation of its progenitors the name which would have been preferred to any other, for the new publication, was THE AMERICAN ENGINEER, but at that time a paper with that title was published in Chicago. Since then it has been discontinued, and therefore the name could be assumed by us if we were disposed to adopt it. For the reasons given it has been determined to make use of that privilege; and although a change in the title of a periodical publication is attended with obvious—but, it is thought, merely temporary—disadvantages, it is believed that they are not so great as the detriment resulting from the continued use of a name which is not sufficiently distinctive and is difficult to recall.

It must be understood, however, that the change of name does not imply any change of control; nothing but the title of our late cotemporary has been adopted, and the ownership and the editorial staff of the paper will continue the same as heretofore.

The new name will indicate distinctly the character which this publication is intended to have. It was announced in the first number of the RAILROAD AND ENGINEERING JOURNAL that it "will be devoted to the discussion of engineering and mechanical subjects. Railroad construction and operation being, however, the most important branches of engineering in this country, more space will be devoted to them than to any other one department of engineering." The general scope of the paper under its new title will not be materially changed. Its form and size will remain the same, but new type and a quality of paper better suited for the printing of process engravings will be used. It is intended to have a larger proportion of original articles than heretofore, and to make material improvements in the character of the illustrations published.

Among the articles already provided for, it may be mentioned that Dr. Dudley's interesting series of Contributions on Practical Railroad Information will be continued; and Mr. Chanute's on Progress in Flying Machines will also be continued and concluded. Fully illustrated descriptions of locomotives, cars, stationary and marine engines, shop appliances and practice by different builders will be given from time to time.

A series of articles on what may be called Comparative Anatomy of English and American Locomotives is commenced in the present number. These will be illustrated by very complete detailed engravings showing the construction of the engines and of the different parts or organs of the most recent express locomotives built for the London & Southwestern Railway, and of the engine with 7-ft. driving-wheels now running on the New York Central & Hudson River Railroad, an illustration of which was given in the November number. These illustrations will be fully described in critical articles comparing the construction and performance of both engines. This discussion will be continued through the greater part of the year 1893, and will, it is thought, give a better idea of the peculiarities of construction of both English and American locomotives than it is possible to obtain from any existing source.

Other new features will be added to the paper from time to time, and it will be the aim of its editors and proprietor to make the rechristened paper such a record of the work of THE AMERICAN ENGINEER as shall be a warrant for the use of that title.

EDITORIAL NOTES.

THE report of the Interstate Commerce Commission, which has just been presented to Congress, shows that the work of the Commission has been well continued. A large number of cases have been passed upon, and the report gives some idea of the great amount of detail work required in carrying out the law. Some important questions have arisen during the year, and in several cases references to the courts have been required. The Commission is decidedly a working body, and as little delay as possible is allowed in its decisions.

THE work of the Commission has brought about many changes in the way of equalizing rates and removing discriminations. This is a result of the law which is generally appreciated, and has done much toward securing public support for it. The regulation or fixing of rates is not within the powers of the Commission, but unjust discrimination and unequal charges can be prevented, and the action taken under the law has been steadily directed to that end.

SOME reference has heretofore been made to the statistical work done under direction of the Commission and its value. The report refers to this, and to the improvements which are looked for in future work of this class.

Some important amendments to the law are pending, chiefly in the direction of increasing the powers of the Commission in securing information and in enforcing its decisions. The weak points have been shown by experience, and the amendments recommended are chiefly in the direction of making the law more complete.

Reports come from Russia of some trials of armor-plates, in which the methods adopted at Annapolis and Indian Head seem to have been quite closely followed. The results were not favorable for the English Brown plates, which were badly shattered, while the Cammell plates also suffered severely, although one of the latter almost succeeded in passing the test. The best results were obtained with plates from the St. Chamond Works, in France. One of these, it is said, is reserved for a further test in competition with an American steel plate treated by the Harvey process.

Reference was made in our issue of April last to an experiment with a closed cylinder, representing a section of the 5-in. Brown wire-wound gun. A maximum recorded pressure of nearly 54,000 foot-pounds failed to burst the cylinder; but reasons for declining to accept this test as conclusive of the endurance of the finished gun were given at some length.

On December 3 three shots were fired from a completed gun, or, rather, from a gun which had reached the stage of being rough bored. Charges of 10 lbs., 15 lbs. and 18 lbs. of sphero-hexagonal powder behind an 84-lbs. projectile were used. For the second and third shots pressures of something over 28,000 and 60,000 lbs. per square inch respectively are reported. The gun was uninjured. In view of the often erratic behavior of pressure-gauges, however, we can be pardoned for hesitating to accept the record of a single shot as proving this gun superior to any other heretofore known, the ordnance expert to the contrary notwithstanding.

THE SIBERIAN RAILROAD.

In the Journal for March, 1891, it was stated that the surveys for the Oussouri Section of the Great Siberian Railroad were made in 1887 and 1888. This is the extreme eastern section, connecting the line with its terminus on the Pacific.

In the spring of 1891 work on this section was formally begun, the occasion being marked by the presence of the Czarevitch Nicholas. It was then decided that this section should be built from the port of Vladivostok to Grafskaia on the Oussouri, a distance of 256 miles; and that surveys should be made for an extension of 200 miles from Grafskaia to Khabarovka, the administrative capital of the province.

But little work, however, has been accomplished during the seasons of 1891 and 1892. According to recent advices from St. Petersburg the work has been scattered over the first 160 miles, the grading at some points being completed, but at others hardly begun. About half of the earthwork —or 4,500,000 cubic yards—is completed, but the half remaining to be done is in a marshy and difficult country. Tracklaying was begun in September, but only 8 miles have been completed.

The working force employed consisted of about 3,000 soldiers and an equal number of convicts and exiles. A few Chinese and Coreans were employed for a time, but they did not prove satisfactory, being hardly strong enough, and the prisoners formed the main working force. After finishing the heavier earthwork of the first section, they are now employed in building the road through the great *taiga* or forest, about 150 miles from Vladivostok, where the convict administration has concentrated its force.

The tracklaying from Vladivostok to Nikolsk, the first important station—a distance of 66 miles—can hardly be finished before next fall.

The first cause of delay was the wreck in the Suez Canal of the German steamer *Triton*, which had on board six locomotives and a large quantity of rails, which should have been delivered to the road last spring. After much delay it was only in October last that the locomotives were finally recovered and forwarded on the steamer *Kostroma*.

Another correspondent says that there is still much unfinished work. A few section-houses have been built, but nothing has been done on the stations, and only the foundations of the terminal buildings at Vladivostok have been built.

At the beginning of 1891 the work was placed in charge of Chief Engineer Ursatti. He unfortunately became involved in misunderstandings with Baron Korff, the Governor-General of the Amour territory. This trouble culminated in the sending out of a commission of investigation, at the head of which was Mr. O. P. Viazemski, who was finally, in October last, appointed Chief Engineer in charge of construction, Mr. Ursatti being removed.

The new Chief Engineer, Mr. Viazemski, is well known in Russia as a civil engineer of ability. He had charge of the surveys of the Trans-Baikal section of the Siberian road and of the Baikal loop line, and is thoroughly acquainted with Eastern Siberia. He is, moreover, a personal friend of the Governor-General, Baron Korff, and will work in harmony with him. It is hoped that under his control the construction of the Oussouri Railroad will be quickly completed.

Still later advices give the official programme adopted by the Ministry of Lines of Communication, which provides for the construction of the entire line from Chelabinsk to Vladivostok in 12 years; the distance being 7,350 versts, or 4,900 miles. It is proposed to use for the present steam ferries at the crossings of the Irtish, the Obi, the Yenisei and the Amour, the building of the great bridges over these rivers being postponed until later.

In the season of 1893 work will be in progress on the following lines:

1. The Western Siberian Line, from Chelabinsk to the Obi River, 1,328 versts—885 miles—under charge of Chief Engineer Mikhailovski.
2. The Central Siberian Line, from the Obi River to Irkoutsk, 1,754 versts—1,170 miles—under charge of Chief Engineer Mejininov.
3. The Ekaterinburg-Mias Branch of 238 versts—159 miles—which will connect the Oural Railroad with the systems of European Russia. This will also be under the charge of Mr. Mikhailovski.

This official programme names the dates for completion of the several sections of the line as follows:

1. In 1894 the Oussouri Line, from Vladivostok to Grafskaia and the Ekaterinburg-Mias Branch.
2. In 1896 the main line from Chelabinsk to Krasnoiarsk, including the entire Western Siberian Line and a portion of the Central section.
3. In 1900 the remainder of the Central Siberian Line from Krasnoiarsk to Irkoutsk, and the extension of the Oussouri Line from Grafskaia to Khabarovka.
4. Finally, in 1904, the remainder of the main line from

Irkoutsk to Khabarovka, including the Baikal loop, the Trans-Baikal Line and the Amour Line. The last named has not yet been located.

It will be of interest to give the estimated cost of the line as now presented by the engineers :

Section.	Length.	Estimated Cost.
	Miles.	
Western Siberian:		
Chelabinsk to the Obi River	883	$22,800,000
Central Siberian:		
Obi River to Irkoutsk	1,110	40,200,000
Baikal Loop:		
Around Lake Baikal	194	13,200,000
Trans-Baikal:		
Lake Baikal to Sretensk	663	32,400,000
Amour Line:		
Sretensk to Grafskaia	1,600	76,200,000
Oussouri Line:		
Grafskaia to Vladivostok	252	10,800,000
Total, Chelabinsk to the Pacific	4,702	$195,600,000

This estimate, which gives an average of $41,600 per mile, includes sufficient equipment for a light traffic. The most expensive section is the Baikal loop, which requires some very heavy work, as noted in our earlier accounts of the surveys.

It will be seen that the Ministry has given up the original plan of using water lines as part of the route, and has now finally decided in favor of the building of the continuous rail line.

We may add that the Zlatooust-Chelabinsk Railroad, which connects the Russian railroads with Chelabinsk, the starting-point of the Siberian Line, was formally opened for traffic in October.

THE HORSE-POWER OF A LOCOMOTIVE.

A CORRESPONDENT from South America asks the following question :

What is the best and simplest method of calculating the horse-power of a locomotive—that is to say, to find some fixed power for any given locomotive? Naturally an engine will vary in its effective power according to conditions—going down a grade, up a grade, or on the level. To calculate the horse-power of any stationary engine I fully understand, but have long been puzzled to find out means to obtain the horse-power of a locomotive. Perhaps the term horse-power is misapplied in connection with a locomotive, and that all that is required is *capacity* to haul so many tons.

The inquiry of our correspondent is one which is often made, and is generally left unanswered, or the querist is silenced by the remark that " We don't count the power or capacity of a locomotive by horse-powers." There is no reason, however, why it should not be possible to calculate the horse-power of locomotive engines as well as that of stationary or marine engines. It is of course true, as our correspondent remarks, that " a locomotive engine will vary in its effective power according to conditions—going down a grade, up a grade, or on a level." In other words, a locomotive has a maximum horse-power at different speeds, and it may develop any horse-power *less* than its maximum at any speed. The most important aspect of the question, then, will be to ascertain the *maximum* horse-power which a locomotive will develop at different speeds. It may also be said here, that what follows will have no reference to that old myth called a " nominal horse-power" established about a century or more ago by the practice of Boulton & Watt. Only actual or indicated horse-power will be considered.

There are two sources from which we may obtain the requisite data to calculate the actual horse-power of a locomotive : one is the effective pressure in the cylinders, which is shown by an indicator ; the other is the work done by the locomotive—that is, overcoming the resistance of the train hauled. Thus, suppose that an engine which, with its tender, weighs 75 tons (of 2,000 lbs.), and has 60,000 lbs. adhesive weight on its driving-wheels, pulls a train of cars weighing 1,500 tons on a level and straight track at a speed of 10 miles per hour. The resistance of such a train in good condition would be about 5 lbs. per ton, and we would have total weight of cars, engine and tender of 1,575 tons $\times$ 5 = 7,875 lbs. Allowing $7\frac{1}{2}$ lbs. per ton on the weight of engine and tender for the friction and resistance of the machinery, and we have 75 $\times$ $7\frac{1}{2}$ = 562.5 and 7,875 lbs. + 562.5 = 8,437.5 = total resistance of train. At 10 miles an hour the train is moving at a speed of 880 ft. per minute ; 880 $\times$ 8,437.5 = 7,425,000 = number of foot-pounds of work exerted by the engine per minute. As is well known, a horse-power is equivalent to raising 33,000 lbs. one foot high, or exerting that many foot-pounds per minute ; therefore 7,425,000 $\div$ 33,000 = 225 = the horse-power of the engine working under these conditions. Now we may calculate, in a similar way, the resistance of any train which a locomotive has hauled or may haul at a known speed, and from this deduce the horse-power exerted. To do this a very convenient table of train resistances at different speeds and on different grades will be found in *The Catechism of the Locomotive*. It should be added that our knowledge of this subject is not very exact, and probably the resistances given in that table are too high. It will be safe to deduct 1.5 lbs. in all cases from the resistances given in the table if the rolling stock is in good condition. The same remark will apply to our knowledge of the internal resistance of the machinery of a locomotive. The rule given by Molesworth for the friction of engines may be used—that is, divide 18 by the square root of the diameter of the cylinders in inches ; the quotient will be the steam pressure in pounds per square inch required to overcome the internal friction of the machinery. This known, the tractive force which that pressure would exert may be calculated by any of the rules for that purpose. From such data the horse-power which a locomotive actually exerts may be calculated for any conditions of working.

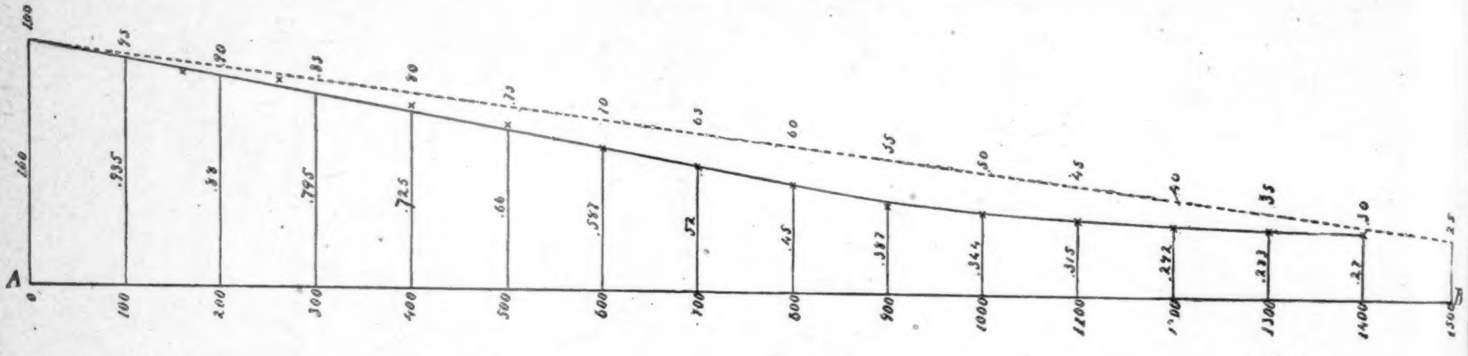
In Clark's *Railway Machinery* the following rule is given :

" *For the Horse-power of a Locomotive.*—Multiply the speed in miles per hour by the square of the diameter of the piston in inches—by the stroke in inches—and by the effective mean pressure on the piston in pounds per inch ; divide the product by the diameter of the driving-wheels in feet, and by 4,500. The final product will be the horse-power."

Another rule would be, multiply twice the area of one of the pistons (for simple engines) by the effective mean steam pressure in the cylinders—the product by the average piston speed in feet per minute, and divide by 33,000. The quotient will be the horse-power.

Now, in both these rules the difficulty will be to ascertain the effective mean steam pressure in the cylinders. Of course if indicator diagrams have been taken, and it is desired to know what horse-power was developed at the time the diagrams were taken, the latter will give the effective

average steam pressure; but as we understand our correspondent's inquiry, he wants some rule by which he can calculate the horse-power of any locomotive of which he knows nothing but its dimensions and the boiler pressure. The missing link in such cases is the average effective steam pressure in the cylinders. In starting and at very slow speeds it is, of course, possible to get an average pressure in the cylinders very nearly as great as that in the boiler, but a little calculation and less practical expense will show that at high speeds—say 60 miles an hour—no locomotive can have an average pressure in the cylinders anywhere near to that in the boiler. Even if it was practicable at that speed to get enough steam of that pressure into the cylinders to fill them and get it out again at the end of the stroke, no boiler now in use could supply enough of it. Locomotive driving-wheels 5 ft. in diameter, at 60 miles an hour, would make over 20,000 revolutions per hour. If the cylinders are 18 × 24 in. they would consume more than 100,000 lbs. of steam of 150 lbs. pressure if they were filled with it and it



was exhausted at each stroke of the pistons. If the grate had 25 sq. ft. of area and burned 150 lbs. of coal per foot per hour, and evaporated 6 lbs. of water per pound of coal, it would produce only 22,500 lbs. of steam per hour. Besides this, it would, as already remarked, be impossible to get that quantity of steam into and out of the cylinders at that speed, and if it was possible to do so, the violence of the exhaust would tear the fire to pieces and carry most of the coal up the chimney. For these and for other reasons the effective mean pressure on the piston in practice is diminished as the piston speed increases. Now at what rate is it reduced? If we can establish some rule of practice, we will have the missing link by which we may be able to calculate the horse-power of any locomotive of which we know the size of its wheels and cylinders and the steam pressure in the boiler, providing, of course, that the boiler and other parts are properly proportioned.

We are indebted to Mr. Reuben Wells, of the Rogers Locomotive Works, for the results of an investigation of this kind. He examined all the indicator diagrams, showing the performance of locomotives which he considered reliable. The results of this investigation are embodied in the table, given in the next column:

Diameter of driving-wheels in inches.	Approximate train speed per hour due to the diameter of drivers.	Piston speed in feet per minute (approximate).	Per cent. of boiler pressure effective on the pistons for the whole length of the stroke.
50 to 54 inches.	6 miles.	160 feet.	88 per cent.
50 " 54 "	10 "	260 "	85 " "
54 " 56 "	15 "	400 "	75 " "
54 " 56 "	20 "	500 "	68 " "
60 " 62 "	28 "	600 "	60 " "
60 " 62 "	33 "	700 "	52 " "
66 " 68 "	40 "	800 "	44 " "
68 " 72 "	45 "	900 "	36 " "
78 inches.	53 "	1,000 "	33 " "
78 "	60 "	1,100 "	31 " "
78 "	65 "	1,200 "	29 " "
78 "	70 "	1,300 "	28 " "
78 "	75 "	1,400 "	27 " "

Implicit reliance cannot of course be placed on these figures. It is only an attempt to work out the problem from the data which are now accessible. In order to show the results graphically, the data contained in the third and fourth column of the table have been plotted in the accompanying diagram. On the base-line *A B* vertical lines or ordinates are drawn, the spaces between indicating average piston speed in feet per minute, each space representing 100 ft. The figures below the base-line indicate the piston speeds represented by each vertical line. From the base-line, at points representing the piston speeds indicated in the third line of the table, there have been laid off to scale vertical distances representing the percentage of boiler pressure effective on the pistons, as given in the fourth column of the table. The points thus laid down are indicated by crosses. A curve has then been drawn through these points as nearly as practicable. The vertical distance of this curve from the base-line at any point should therefore represent the effective boiler pressure in the cylinders for a piston speed indicated by the point on the base-line from which the measurement is made. The figures on the vertical lines indicate the vertical distances of the curve from the base-line measured on these ordinates. These figures, it will be seen, differ slightly from those in the fourth column of the table, as might be expected. The question arises how nearly the curve represents actual practice, or the average effective pressure in the cylinders of locomotives when they are working at their maximum capacity at different piston speeds. If the curve does represent the average effective pressures in the cylinders correctly, then all we need do to calculate the horse-power of a locomotive is to take the required average pressure from the diagram and use it with either of the rules given above.

It is a very inviting field for investigation. If some one having the requisite facilities for doing so would take a series of indicator diagrams, which a well-designed and constructed locomotive would produce when doing the maximum work of which it is capable when working with different rates of piston speed, it would be a very valuable contribution to our knowledge of the subject. It is by work of this kind that unknown men establish reputations, which should be an inducement to some one to undertake it.

Owing to the fact that indicator diagrams are not always, and in fact seldom are, taken when locomotives are doing the maximum work of which they are capable at the speed at which they are indicated, it seems probable that Mr. Wells's figures of average effective pressures may be too low, and it also appears likely that the curve of pressures may assume the form of a straight line, as indicated by the dotted line in the diagram. If this should prove to be the case, then, determining the average pressure for any piston speed would become a very simple matter, and if the average effective pressure at a piston speed of 1,500 ft. per minute was 25 per cent. of the boiler pressure, as indicated in the diagram, then the pressures for the intervening speeds would be as shown by the figures above the dotted line.

Who will undertake the making of such a series of indicator diagrams as have been suggested?

NEW PUBLICATIONS.

CAB AND CABOOSE: THE STORY OF A RAILROAD BOY. By Kirk Munroe. New York; G. P. Putnam's Sons. Illustrated. 264 pages; price, $1.25.

Mr. Munroe has a talent for writing boys' stories which is not very common among authors, for there are many who can write for men where there is one who can suit boys. His stories are usually bright, lively and full enough of incident to be interesting, without descending to the level of sensationalism. In the present book he has told the story of a boy who left home to take up the life of a trainman. Of course his hero is successful, and of course he meets with many adventures which do not often fall to the lot of the occupants of a caboose; but the action is not more overdone than we have to expect in a story, and the Author does not conceal the fact that hard work and hard knocks are a large part of life with the brakeman, as indeed they are with most of us. The hero of *Cab and Caboose* succeeds because he is a bright boy, and if chance throws opportunities in his way that come to a very few in ordinary life, we cannot blame the story-teller. The book is a good one for boys, who may learn some worthy lessons from its pages; and the pictures of railroad life are fairly truthful ones.

ENGINEERS' SURVEYING INSTRUMENTS; THEIR CONSTRUCTION, ADJUSTMENT AND USE. By Professor Ira O. Baker, C.E. *Second Edition, Revised and Enlarged.* New York; John Wiley & Sons. Illustrated, 391 pages; price, $3.

The first edition of Professor Baker's book has found general acceptance as a convenient text and reference book, and the present edition should be still more acceptable. Originally prepared for the use of his students in the University of Illinois and used in manuscript form for several years, the author was able to improve it by consideration of the questions brought up in the classes from time to time, thus adapting it to the requirements of students.

It is not intended to be a treatise on surveying, but simply, as the title indicates, to acquaint the student with the construction of instruments and the best methods of adjusting and using them. Some instruction on methods of surveying has necessarily been included, but this has been avoided as far as possible. It has been found that the practical instruction given to students in a college course needs to be supplemented in order to make them sufficiently familiar with the instruments they have to use.

An appendix gives a number of problems, with methods of solution. The value of the book is increased by a very complete index, and the whole arrangement of its contents is very convenient. The student will find it a valuable work, and the engineer a very useful addition to his library.

ORIGINAL PAPERS ON DYNAMO MACHINERY AND ALLIED SUBJECTS. By Dr. John Hopkinson. New York; the W. J. Johnston Company, Limited. Illustrated, 249 pages; price, $1.

The value of Dr. Hopkinson's studies and investigations on electrical subjects and of his resulting discoveries is well known; but the papers which he has had time to publish have existed heretofore only in a scattered form, as they were first issued in various publications. In this volume they have been collected, by his authority, making them much more useful and accessible to electricians.

Nearly every one of these papers has been the result of some new discovery or marked advance in electrical knowledge. The first three papers are devoted to the Characteristic Curve, which has been so great an aid in studying and designing dynamos.

The fourth and fifth papers are on the theory and design of continuous current dynamos, and furnished the fundamental principles of the design of such dynamos.

The sixth paper established most important principles in relation to coupling alternate current machines. The seventh, eighth and ninth are on Transformers; the tenth on the Theory of the Alternate Current Dynamo; and the last on Electric Lighthouses.

Most of these papers were originally published in the transactions of different societies. With two or three exceptions they contain no mathematical formulas, and most of them can be read and the reasoning followed without any special knowledge of mathematics.

The illustrations, chiefly diagrams, are sufficient, though some of them have been reduced to rather too small a scale.

It may be added that the book includes all the original papers Dr. Hopkinson has published; and some of them are now made generally accessible for the first time.

NOTES ON THE YEAR'S NAVAL PROGRESS. *Annual of the Office of Naval Intelligence, Compiled for the Use of Naval Officers and Others.* Compiled by the Office of Naval Intelligence, Navy Department. Washington; Government Printing Office.

This volume is the eleventh in the series issued yearly by the Naval Intelligence Office, and while it follows the general lines of the previous ones, there has been some change in the methods of treating the different topics.

The general headings are: I. Notes on Ships and Torpedo Boats. II. Notes on Machinery. III. Notes on Ordnance. IV. Notes on Naval Administration and *Personnel*. V. Notes on Electricity. VI. Naval Manœuvres of 1891. VII. Armor in 1892. VIII. Some Standard Books on Professional Subjects.

The notes on Ships and Torpedo Boats, on Machinery and on Ordnance form the principal features of the volume. Chapter IV, Notes on Administration and *Personnel*, forms a new heading, although it is a continuation of articles which have appeared in previous numbers. Chapter V, on Electricity, is in the form of notes on progress made since the appearance of the last volume.

Especial interest attaches to Chapter VII, on Armor, which gives a summary of the very important tests made during the year. This chapter is accompanied by numerous illustrations showing the condition of plates after the tests.

The Notes on Ordnance include some very interesting accounts of recent developments in rapid-fire and machine guns. This chapter also is well illustrated, and, it may be added, does not neglect the subjects of small arms and torpedoes.

The notes on Machinery include accounts of the progress made on new engines for our own Navy, and comparative accounts of the results derived from a number of speed trials.

The vibrations of marine engines and experiments in the use of liquid fuel are also included in the subjects touched on.

The chapter on Naval Manœuvres gives critical accounts of the evolutions of the English, French, German, Austrian and Russian fleets during their customary summer exercises. While these are chiefly valuable to naval officers, they are not without their interest to non-technical readers, as showing the way in which modern ships may be fought in case of actual war.

It may be said that the present volume shows that the Naval Intelligence Office intends to fully maintain the standard set in its previous publications, and to establish its claims to usefulness.

ELECTRICITY AND MAGNETISM: *Being a Series of Advanced Primers.* By Professor E. J. Houston. New York; the W. J. Johnston Company, Limited. Illustrated, 306 pages; price, $1.

A set of Electrical Primers was issued by Professor Houston in 1884 for the benefit of those who desire to acquire some knowledge of the fundamental principles of electricity. The present series is a new one, written in view of the great advances made in electrical science during the past eight years, and also of the fact that the many commercial applications of electricity have made the public generally acquainted with at least the first principles, and that more advanced instruction was asked for. The book, however, can readily be understood by those who have no previous knowledge of the subject.

The book may be divided into three heads: the first, Electricity and Magnetism; the second, Electric Currents and their Measurement; the third, the Electric Telegraph and other applications. The concluding section is a general review. The subjects of the sources of electricity, atmospheric electricity, the earth's magnetism, the electro-magnet, and induction are treated in an interesting way.

To each chapter there are appended abstracts from and references to standard electrical books, a very useful feature for readers who would like to extend their studies.

Although intended for popular reading, the book is not without its uses for electricians.

TIPS TO INVENTORS. *Telling what Inventions are Needed and How to Perfect and Develop New Ideas in any Lines.* By Robert Grimshaw, Ph.D., M.E. New York; the Practical Publishing Company; price, $1.

This is a kind of book which is difficult to criticise. It is a collection of hints as to inventions for which there appears to be a demand; as to methods by which they can be worked out and the routine to be followed in securing a patent. It can hardly be said to follow any definite plan, although it is classified into chapters on different subjects. Of course there is much in it not especially new, but it contains some good suggestions, and the reader may find in it hints that may be of value to him.

CURRENT READING.

THE writers in the NORTH AMERICAN REVIEW for December cover a wide range of topics, and some notable names are included among them. Mr. Balfour discusses the Irish Question from a Tory standpoint; Colonel Dodge writes of the Horse in America; Lord Dunraven of International Yachting; M. Naquet of Divorce; Minister Grubb of Ballot Reform; and Dr. H. G. Williams has a warning if somewhat gloomy article on General Paresis of the Insane. The Governor of Jamaica tells of the Opportunities for Young Men in that island; and there are the usual notes and comments on current events.

The oldest of all the magazines now in existence has recently experienced a revival. GODEY'S MAGAZINE, which for many years had been published in Philadelphia in the same form which was given to it fifty years ago, has passed into new hands, and appears in a shape which indicates the publisher's purpose to bring it to a front rank among its contemporaries. While still devoting a part of its space to the ladies who have heretofore been its chief supporters, it has entered the field of the general literary magazines with a vigor which promises well for the future. The December number, being the special holiday number, is chiefly devoted to fiction, containing a complete novel and several shorter stories. It is very handsomely illustrated, and has several fine colored plates which will be especially interesting to its lady readers.

An article by Professor Heilprin on Summer Travel in the Arctic Regions; one by W. H. Russell on the Fall of Sebastopol and one by C. F. Lummis on an incident in the romantic history of the Southwest, are among the attractions of SCRIBNER'S MAGAZINE for January. Stories, sketches and other lighter matter complete the number.

Some very attractive illustrated articles appear in the January number of HARPER'S MAGAZINE. Among these Julian Ralph's account of The Old Way to Dixie, and Theodore Child's description of life and scenes in Proletarian Paris, will enlist the attention of every intelligent reader. Other articles which will forcefully appeal to the tastes of a cultivated audience are a paper of personal reminiscences of Tennyson, by Annie Fields, and a comprehensive article on Pensions by Edward F. Waite. The number is also particularly rich in fiction, including the opening chapters of two important serials. The editorial departments contain a variety of inviting features.

The December number of the ARENA, which begins a new volume, has some valuable articles presenting different opinions on such questions as Government Ownership of Railroads; Compulsory Arbitration; the Opening of the World's Fair on Sundays; Socialism; and others of almost equal moment. This magazine has done much toward drawing out the best thought on current topics by opening its columns to free discussion and presenting all phases of opinion; and readers who are interested in such discussion owe much to the editor, Mr. B. O. Flower, who had the enterprise to start the magazine and the courage to present the arguments contributed. In no other periodical can the reader find so much food for serious thought and such entire freedom from prejudice and custom.

In OUTING for December Lieutenant Bowen concludes the history of the National Guard of New Jersey. There are sketches of hunting and travel in the Platte Valley, in Manitoba, on the Paraguay, in Ceylon and in the almost unknown region along the border between Canada and the United States west of Lake Superior. An article on Athletics in Japan is illustrated by some very striking reproductions of drawings by Japanese artists. It is a very good number on the whole, and quite worthy of the special holiday cover which ornaments it. The January number is a special holiday number, and is marked by some illustrations of a very high class, and a number of excellent articles.

In the number of HARPER'S WEEKLY for December 7 there is a well-illustrated description of the Military Academy at West Point, showing the improvements made in recent years and also those now in progress. There is also an article on the Panama Canal Crisis in France.

Probably the best of the special magazines which comes to

our table is STONE, a monthly issued in Indianapolis by the D. H. Ranck Publishing Company, and devoted, as its name indicates, to the stone quarrying and building interests. It has 96 pages about the size of *Harper's*, is handsomely printed and well illustrated, and contains much information valuable to its special constituency, while quite a number of its articles have interest for the general reader. The November number has articles on the Marble Region of East Tennessee; the Sandstone Interests of Northern Ohio; the Areal Work of the Geological Survey; Drawing for Workmen; Durability of New York Building Stones; Whetstones in the United States; and a number of short articles, including Notes from the Quarries, Building Items and similar matters.

In the OVERLAND MONTHLY for December the paper on the University of California is concluded, the present number containing some excellent illustrations. The centennial of Vancouver's visit to the Bay of San Francisco in 1792 is the occasion of an interesting paper. Other articles include the Restaurant of San Francisco; a Mexican Ferry; Congressional Reform; and several stories and sketches.

A paper in the POPULAR SCIENCE MONTHLY for January gives an account of the independent invention of the lightning rod by a Bohemian named Divis, a contemporary of Benjamin Franklin. Other leading articles are on Genius and Suicide; on Vegetable Malformations, and on Marriage and Kinship among the Ancient Israelites. There are also several shorter articles of interest.

The December number of the ECLECTIC MAGAZINE gives articles on Cholera, from the *Nineteenth Century;* Columbus, from the *National Review;* China, from the *Cornhill Magazine;* the Recent Heat-Wave, from the *Contemporary Review;* Over Education, from the *Saturday Review;* Our Molten Globe, from the *Fortnightly Review;* and a variety of shorter articles, making altogether an excellent specimen number of current English literature.

The November number of GOOD ROADS has several effective articles, including some illustrations of roads as they are and as they ought to be. That on Street Improvements in Dunkirk shows what can be effected by well-directed work in a small town.

The December number of the ENGINEERING MAGAZINE has articles on Reciprocity with Canada; Architecture in Wood; Building the Cable Railroad in New York; Industrial Development in the South; Our Remaining Hardwood Resources; Irrigation Problems in the West; Labor Troubles and the Tariff; Gold Fields of Bendigo, Australia; the World's Fair and the Death-Rate; Are American Mechanics Boastful? and the usual special departments.

In the JOURNAL of the American Society of Naval Engineers for November Chief Engineer Isherwood gives an analysis of the results of the experiments recently made on the side wheel steamer *Ville de Douvres*, which have attracted much attention abroad. There are papers on Speed Trials, by Naval Constructor Taylor; Propeller Efficiency, by Professor W. F. Durand; and some excellent lectures delivered at the Naval War College by Passed Assistant Engineer Hollis on the Coal Endurance and Machinery of the New Cruisers. There are also several shorter papers and a number of notes on points connected with naval work.

The articles in GOLDTHWAITE'S GEOGRAPHICAL MAGAZINE for November include a continuation of that on Columbus, and papers on Stream Corrosion; the Prehistoric Races of Italy; Modern Palestine; the Chinaman in America; the Florida Gulf Coast; the Temperature of the Circumpolar Regions; the 84th Eruption of Mt. Etna; and several shorter articles.

BOOKS RECEIVED.

Twenty-third Annual Report of the State Board of Health of Massachusetts. Henry P. Walcott, M.D., Chairman of Board; Samuel W. Abbott, M.D., Secretary; F. P. Stearns, C.E., Engineer. Boston; State Printers.

Results of Tests of Crucible, Basic and Galvanized Basic Steel Wire Ropes and Basic Steel Wire Rods. Bulletin No. 11 of the Department of Mechanical Engineering, University of California. San Francisco; published for the University.

River Pollution and River Purification. By H. Alfred Roechling, C E. This is a reprint of a paper read recently before the Association of Municipal & County Engineers, at the annual meeting in Bury, England.

Selected Papers of the Institution of Civil Engineers. London, England; published by the Institution. The present installment includes the annual address of the President, Mr. Hayter; papers by Mr. Donkin on Measurement of the Velocity of Air in Pipes; Mr. Preller on the Zurich Water Power and Electric Light Works; and Mr. Szlumper on the Waterloo New Signal-Station.

The Inclined Plane for the Transfer of Canal Boats at Beauval, near Meaux. By M. A. Mallet. Paris. This is a reprint of a paper read by M. Mallet before the French Society of Civil Engineers.

John Stevens and His Sons: Early American Engineers. By J. Elfreth Watkins. Washington; published for the Author. This is a reprint of a very interesting paper read by Mr. Watkins before the Philosophical Society of Washington.

Annual Report of the Postmaster-General of the United States for the Fiscal Year Ending June 20, 1892: Hon. John Wanamaker, Postmaster-General. Washington; Government Printing Office.

TRADE CATALOGUES.

How to Use Portland Cement. The Buckeye Portland Cement Company, Bellefontaine, O.

This little pamphlet contains notes on various uses to which Portland cement can be put; and incidentally, some advertising of the Buckeye Company's cement, the good qualities of which are well known.

Hydraulic and Rolling Mill Machinery. H. V. Loss, Hydraulic Engineer, Philadelphia.

This pamphlet describes several hydraulic machines devised by Mr. Loss, including riveting and forging machines; shears and punches; high-pressure pumping engines; accumulators for hydraulic presses; valves, packing and other fitting.

Steel Castings. The Pittsburgh Steel Casting Company, Pittsburgh, Pa.

This pamphlet contains some interesting information about steel castings in general, and some statements as to the work done by this company. Some of its specialties are hammer heads and dies, cams, rolls, gearing of all sorts, and wheels, although all classes of castings are made in its works. Reports of recent tests show excellent results, which can only be obtained by the use of the best material and most approved processes.

The Columbia Daily Calendar. The Pope Manufacturing Company, Boston, New York and Chicago.

This is a very handy pad calendar, consisting of 366 leaves, one for every day in the year, and a calendar for the entire

year. The day of the week, of the month, and of the year are given, and on each leaf is a short sermon on the Gospel of Outdoors, Health and Happiness, with valuable hints on practical road-making. The leaves are so arranged that there will be no stub left, and each one can be referred to at any time during the year. The pad is upon a metallic stand of ivory black, arranged so as to rest upon the desk at a convenient angle.

Catalogue of the Consolidated Car-Heating Company, Albany, N. Y. Part IV. Multiple Circuit System. Illustrated.

The Consolidated Car-Heating Company has adopted the novel plan of sending out its new catalogue in parts, so arranged that as each additional part is received it can be bound up with the earlier ones, a simple binding arrangement being provided. The present part contains an illustrated description of the company's multiple circuit system of car heating, a new arrangement for heating by hot water. When complete this catalogue will form quite an encyclopædia of continuous heating. It is handsomely printed and well illustrated.

AMERICAN AND ENGLISH LOCOMOTIVES.

THE double-page engraving with this number is the first of a series of illustrations of two passenger locomotives, one of them designed by Mr. William Buchanan, Superintendent of Motive Power and Rolling Stock of the New York Central & Hudson River Railroad, and built by the Schenectady Locomotive Works. This engine, No. 903, is now running on the New York Central Line, and is one of the engines employed to haul the celebrated Empire Express. The other one was designed by Mr. W. Adams, Locomotive Engineer of the London & Southwestern Railway of England, and built at the Nine Elms Works of that company. These two engines are fair representatives of recent locomotive practice in the two countries. In succeeding numbers of this JOURNAL it is intended, as already announced, to give a series of engravings, which will be published on opposite pages, showing the design and construction of all the principal parts or organs of these two machines, with descriptive and critical articles comparing the methods of construction of the two, and showing the relative advantages and disadvantages of each. In this introduction but little seems to be demanded, excepting to give the general dimensions, weight, etc., of the two locomotives, reserving the summing up until after the details have been fully illustrated and described.

From the table and the engravings it will be seen that the size of the driving-wheels of the two engines is within half an inch of being the same. The cylinders are of equal diameter, but the pistons of the English locomotive have two inches more stroke than those of its American competitor. Mr. Buchanan's engine, however, is 13,968 lbs. heavier than Mr. Adams's, and the former has 13,328 lbs. of its excess of weight on the driving-wheels. The New York Central machine, therefore, has 66.83 per cent. of its weight on the driving-wheels and the London & Southwestern engine has 62.26.

The rule which has been given for ascertaining what has been called the *modulus of propulsion*, or the measure of the capacity of the cylinders in proportion to the size of and weight on the driving-wheels, is:

"Multiply the area of one piston (in square inches) by the stroke (in inches) and the product by four. Divide this product by the circumference of the driving-wheels (in inches) and by the weight (in tons of 2,000 lbs.) on all the driving-wheels. The quotient will be the modulus of propulsion."

By applying this rule to both engines, we find that Mr. Adams's engine has a modulus of 3.28, whereas Mr. Buchanan's has only 2.49. It is true that the latter has a boiler pressure 5 lbs. greater than the former, which partly compensates for his smaller cylinder capacity. If we multiply the moduli by the boiler pressures it will give us quantities which represent correctly the relative capacity of cylinders, taking all the elements into account. These will be 590.4 for the English and 460.65 for the American engine. It will be seen from these figures that Mr. Adams's

GENERAL DIMENSIONS, WEIGHTS, ETC., OF LOCOMOTIVE NO. 903, OF THE NEW YORK CENTRAL & HUDSON RIVER RAILROAD, AND LOCOMOTIVE NO. 577 OF THE LONDON & SOUTHWESTERN RAILWAY.

	American Engine.	English Engine.
Diameter of driving-wheels	84½ in.	85 in.
" " engine, truck and tender wheels	36 in.	45¾ in.
" " cylinders	19 in.	19 in.
Stroke of pistons	24 in.	26 in.
Lap of valve	1 in.	1 in.
Maximum travel of valve	5½ in.	.. ...
Length of connecting-rod, center to center	8 ft. 1 in.	6 ft. 8 in.
Proportion of length of connecting-rod to stroke.	1 to 4.04	1 to 3.07
Smallest outside diameter of boiler	58 in.	52 in.
Number of tubes	268	240
Length " "	12 ft.	11 ft. 4 in.
Diameter of tubes	2 in.	1¾ in,
Area of grate	27.3 sq. ft.	18 sq. ft.
Total heating surface	1821.5 sq. ft.	1,367.76 s. ft.
Height from top of rails to center of boiler	8 ft. 10¾ in.	7 ft. 9 in.
Boiler pressure	180 lbs.	175 lbs.
Total weight of engine and tender	203,500 lbs.	180,712 lbs.
" " " "	123,000 lbs.	109,032 lbs.
" " on driving-wheels	82,200 lbs.	67,872 lbs.
" " of tender, loaded	80,500 lbs.	71,680 lbs.
" length of engine and tender, over all	56 ft. 7¾ in	53 ft. 8⅝ in.
" wheel-base " " " "	46 ft. 8½ in.	45 ft. 8½ in.
" " " "	23 ft. 11 in	23 ft.
Driving wheel-base	8 ft. 6 in.	8 ft. 6 in.
Weight of engine and tender per foot run of total length	3,595 lbs.	3,364 lbs.
Weight of engine per foot run of total length	3,471 lbs.	3,404.8 lbs.
" " tender " " " " " "	3,795 lbs.	3,360 lbs.
Water capacity of tank	3,587 galls.	3,300 galls.
Coal " " "	14,500 lbs.	......

engine has, relatively to its weight, considerably more cylinder capacity than the American competitor. On the other hand, the grate and heating surface in the latter is considerably greater than in the English machine, which is a consequence or result accruing from the excess of weight. These features will be discussed more fully in future. In the mean while, many of our readers will be interested in comparing the designs of the two machines.

SOME CURRENT NOTES.

As an example of the useful work which a technical school may undertake, Professor W. F. M. Goss, of Purdue University, at Lafayette, Ind., offers, through *Stone*, to make a full series of tests of Indiana building stones. The only conditions are that samples of the stone shall be forwarded to the Testing Laboratory of the University in 2-in. cubes ready for testing and properly marked and authenticated. The results of the tests will be a matter of record at the Laboratory, but will not be published except at the request of the owners of the specimens.

SHIPS, like men, sometimes come down in the world very much in their old age. Just before the War the *Santiago de Cuba* was the crack ship of the line between New York and Havana; during the War she was a naval cruiser and was considered one of the finest and fastest vessels in the blockading squadron, capturing as many prizes as any ship in the Navy. After the War she was sold, with many others, and after a varied service her hull, stripped of its cabins and other upper works, is now doing duty as a coal barge. The beam engine is still at work, however, having been put into the large excursion steamboat *Columbia* some years ago.

A FRENCH authority estimates the quantity of coal mined throughout the world in 1891 at 485,000,000 tons, the output from different countries being as follows: Great Britain, 182,000,000; United States, 141,000,000; Germany, 90,000,000; France, 28,000,000; Belgium, 20,000,000; Austria-Hungary, 9,000,000; Russia, 6,000,000; other countries, 9,000,000 tons.

The production for 1892 has probably been over 500,000,000 tons. At the present rate of increase the deposits of some of the leading coal-producing countries must soon be at least partially worked out. Within a few years Great Britain and Belgium will probably show a decrease; in a few years more the United States will become a coal-exporting country, while further in the future North China and Eastern Siberia will begin to contribute to the world's supply from the great coal deposits which are believed to exist in them.

WORK has been begun on the reclamation of the Zuyder Zee in Holland. This will require the construction of a dam from Ewijeksluis, in North Holland, to the island of Wieringen and thence to Makkum, in Friesland. The dam will be 18 miles long, and will be built through water from 13 to 20 ft. in depth; it will be carried to a height of 16½ ft. above low water, and its slopes will be protected by mattresses and riprap. There will be 24 flood-gates, each with an opening of 41 ft. Near the center of the present water area enclosed a lake will be left, which will be called the Yssel Meer, and this will be connected with the sea at Harlingen, in Friesland, by a canal 1,640 ft. wide and 14½ ft. deep. This lake will also be connected with Amsterdam by a canal. The estimated cost of the work is $95,000,000, which will be more than repaid by the value of the land reclaimed, nearly 1,000,000 acres.

THE work of draining Lake Angeline, in the Lake Superior iron region, has been completed. This lake was three-quarters of a mile long, one-third of a mile wide and 45 ft. deep at the center, and the work was undertaken by the mining companies whose properties adjoined it, and who wished to extend their workings under the bed of the lake. The outlet was closed and the water has been pumped into Carp River by large centrifugal pumps.

IT is now stated that the Hamburg-American Packet Company has closed a contract with the Vulcan Ship-building Company, at Stettin, Germany, for a twin-screw steamer to be 600 ft. long and to have a guaranteed speed of 22 knots an hour. The ship will be about the same size as the new Cunard Line steamers, and is to be finished in two years.

THE University of Chicago is to have the largest telescope in the world, which will be named the Yerkes Telescope, after the giver. It will have a 40-in. objective, that of the Lick Observatory telescope, in California, being 36 in., and that of the new Naval Observatory telescope, in Washington, 26 in. The tube of the new telescope will be 75 ft. long, and will weigh about 12,000 lbs. It is to be built by Warner & Swasey, of Cleveland, O., the builders of the Lick instrument.

THE export of steel from the United States to England has not been considered an ordinary operation; but it seems that steel and also files are now being sold in that country by American makers. A recent number of the London *Engineer* gives the following note from its Sheffield correspondent: "A Sheffield commission agent called upon me this week with specimens of American-made files, of which he had been asked to undertake the sale in this country. The United States people offer their files on terms which cut out local makes—viz., 70 per cent. discount and 5 off; in other words, for a nominal value of £100 they will take £28 10s. The files have been shown to file makers, and have been declared to be satisfactory in regard to quality. The United States firm, whose place of business is in New Jersey, state that they are sweeping the Canadian and Australian markets by running out the best brands of English files. To Canada, where the duties on English and American files are similar, they state that they are sending from $25,000 to $40,000 worth of goods a year, and are now opening up a connection in England itself, sending over from 200 to 300 dozen files per month. The American, of course, does not underrate himself or his productions; but it is certainly significant that he can place on the English market files which English managers declare to be excellent, at rates below local price lists. The files, it should be added, are machine-made in every instance. Another American steel house has stored in London several hundred tons of the best crucible steel, and have already engaged a Sheffield gentleman to represent them in this country."

THE Canadian Government engineers have completed borings and preliminary surveys for the proposed tunnel under Northumberland Straits, to connect Prince Edward Island with the main-land. The distance is eight miles, the greatest depth of water 96 ft., and the bottom is generally favorable for tunneling.

THE pollution of the Seine by the sewage of Paris has become recently so serious a matter that it is proposed to build a trunk or canal sewer the entire distance from Paris to the sea. At present the sewage is distributed to farms at points just below the city, but this arrangement has proved insufficient, and a large quantity passes into the river.

UNDER the direction of the Lighthouse Board some interesting experiments have lately been made at Long Beach to determine the relative visibility of white and colored lights. While there is some difficulty in securing uniform results, it was decided that a white light of one candle-power could be seen one mile distant; two candle-power, two miles, and 30 candle-power, five miles. Red and green lights required four candle-power to make them visible at one mile, and 40 candle-power for two miles. The great difference is due to the absorption of light by the colored glass.

IT is stated that arrangements are in progress for resuming work on the ship railroad across the Chignecto isthmus, in Nova Scotia, which is to carry vessels from the head of the Bay of Fundy to Northumberland Straits. A large part of the work has been completed, but work was stopped some time ago on account of lack of money.

SOME experiments are to be made at the lighthouse station at Tompkinsville, N. Y., with a flash-light of great power, invented by Professor Schirm, of Berlin. The flash is produced by a jet of magnesium powder ignited by a small benzine lamp. Air is passed through cylinders containing pumice stone saturated with benzine, and the gas is thrown out with a spray of magnesium powder against the lamp and thus ignited. The interval between the flashes is regulated by clock-work.

THE addition of small portions of citric acid, tartaric acid, or hydrochloric acid to water is said, by good medical authority, to be efficacious in destroying cholera germs. This can often be done where it would be difficult to boil the water.

A NEW storage battery electric car is now running experimentally on the Ninth Avenue surface line, in New York, which has very heavy grades. The car weighs 12,500 lbs., the batteries of 144 cells weighing about 3,900 lbs. They can operate the car for about six hours of continuous running without renewal.

SOME tests of the Baker submarine boat, which has been described and illustrated in our columns, are now being made in Lake Michigan, near Chicago. So far this vessel has been remarkably successful.

THE new steamers for the Inman Line between New York and Southampton have been begun. Two of them are to be larger than the *City of New York*, and will have engines capable of working up to 25,000 H.P.; four will be somewhat smaller, and will have engines of 17,000 H.P. All the ships will have twin screws and quadruple-expansion engines, working at 210 lbs. pressure.

THE New York, New Jersey & Eastern Railroad Company has recently filed maps and profiles for a double-track railroad tunnel to extend from the Long Island Railroad tracks in Brooklyn, under Atlantic Avenue and the East River to the lower part of New York, and thence under the Hudson River to a connection with the Pennsylvania Railroad in

Jersey City. The plans include stations at convenient points, to be connected with the tunnel by elevators. The project has before been referred to, and it is understood that it has the support of Austin Corbin and others connected with the Long Island Railroad. The tunnel will be about $3\frac{1}{2}$ miles long, and its estimated cost is about $7,000,000.

THE report of General T. L. Casey, Chief of Engineers, for the year ending June 30 shows that there are now 117 officers holding commissions in the Corps of Engineers. Of these 20 are employed on various special duties; 20 on detached service; 14 are serving with the Engineer Battalion and the Engineer School; 30 are engaged on fortifications and river and harbor work, and the remaining 33 are exclusively employed on river and harbor improvement work.

FOR the first time in 15 years construction work on coast fortifications has been resumed, appropriations having been made in 1890 and 1891 for the building of new batteries at Boston, New York, Hampton Roads, Washington, and San Francisco.

THE report of the Board on Ordnance and Fortifications, which has just been submitted, makes some important recommendations. In brief the Board asks for:

1. Greater facilities and increased appropriations for testing and proving guns, mortars, etc.;
2. A Government gun and mortar carriage factory which can turn out mounts commensurate with the production of guns and mortars;
3. The early test and selection of an acceptable type of disappearing carriage for 8-in. and 10-in. guns;
4. Increased and immediate appropriations for the acquirement of sites and construction of additional gun and mortar batteries, and
5. A constant supply of forgings commensurate with the output of the army gun factory.

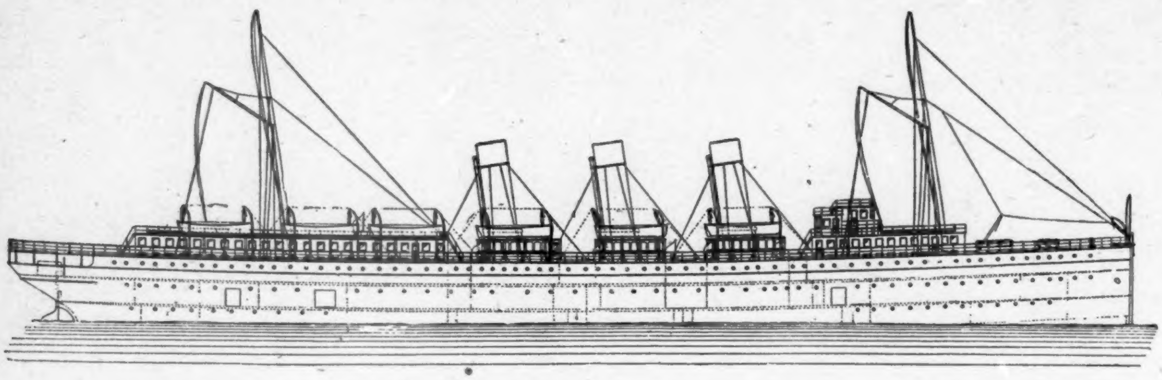
The Board submits an estimate of an appropriation of $270,207 to make purchases, experiments and tests to ascertain the most effective guns, small arms, ammunitions, armor-plates, etc. The Board recommends a repeal of the law pledging the United States to the purchase of 50 cast-iron mortars, 50 10-in. and 50 12-in. guns.

THE Sault Ste. Marie Canal closed for the season on December 7. The freight which passed through this year reached 11,241,000 tons, an increase of 2,325,000 tons over last year. Every important article of commerce shows an enormous increase—grain 61 per cent., flour 43 per cent., and iron ore 38 per cent.

IT is stated that recent improvements in the Sims-Edison torpedo have much increased its speed and the ease with which it can be steered. Some extraordinary results in passing under booms and other obstacles have been attained in recent experiments at the torpedo station at Willet's Point. A speed of 18 miles an hour has been given the torpedo, and at that rate it struck and then passed under a heavy spar and continued its course without damage.

ON December 1 there were, according to the *American Manufacturer's* tables, 255 furnaces in blast, having a total capacity of 175,921 tons of pig iron per week—an increase of 1.1 per cent. over the November statement. The comparison with December 1, 1891, however, shows a decrease of about 10 per cent. in the weekly output. It is still large, and the present tendency is toward a gradual increase.

THE Globe Iron Works, in Cleveland, have now on the stocks two steamers, the first of a line to run between Buffalo and Duluth for the Great Northern Railroad Company. They are 360 ft. keel, 380 ft. over all, 44 ft. beam and 34 ft. deep. They will have accommodations for 320 cabin and 300 steerage passengers. They will carry water ballast in a double bottom so that their draft of 18 ft. on the open lakes can be reduced when necessary to enter a harbor. As will be seen from the accompanying sketch—from the *Marine Review*—they will present the general appearance of an ocean steamer, rather than of the ordinary lake boat, the sides being carried up to the top of the cabins.



PASSENGER STEAMER FOR THE GREAT NORTHERN LINE ON THE LAKES.

Mechanically their peculiarities will be in the use of twin screws, each driven by a quadruple-expansion engine with cylinders 25 in., 36 in., $51\frac{1}{2}$ in. and 74 in. × 42 in., and in the use as steam generators of tubulous boilers of the Belleville type, working at 210 lbs. pressure. Each ship will have 28 of these boilers, and their arrangement has been designed by Mr. Miers Coryell, of New York. The engines are designed to develop 7,000 H.P., and to give the ship a speed of 20 miles an hour.

THE first locomotive built in Australia has just been completed by the works of David Munro & Company in Melbourne, for the Victorian Government Railroads. It is similar to a number in use on those lines, and is a tank engine having four coupled drivers $60\frac{1}{2}$ in. in diameter under the boiler; a pair of 42-in. leading wheels at the forward end and a pair of 42-in. trailing wheels behind the fire-box. The cylinders are 17 × 26 in., placed inside the smoke-box. Water is carried in side tanks and in a tank placed on the frames behind the fire-box.

THE Argentine Republic has now 7,310 miles of railroad, besides 1,520 miles under construction. Of the completed mileage 4,523 miles are of 5 ft. 6 in. gauge; 634 miles of 4 ft. $8\frac{1}{2}$ in.; and 2,153 miles of meter gauge. The average cost of all the lines is reported at about $50,000 per mile. Only 186 miles have a double track.

The State lines include 638 miles; the guaranteed lines—that is, lines built by companies whose securities are guaranteed by the Government—2,024 miles; and the unguaranteed lines owned by companies 4,648 miles. There are in use on these roads 699 locomotives and 1,192 passenger cars; the number of freight cars is not stated, but their total capacity is rated at 268,000 tons.

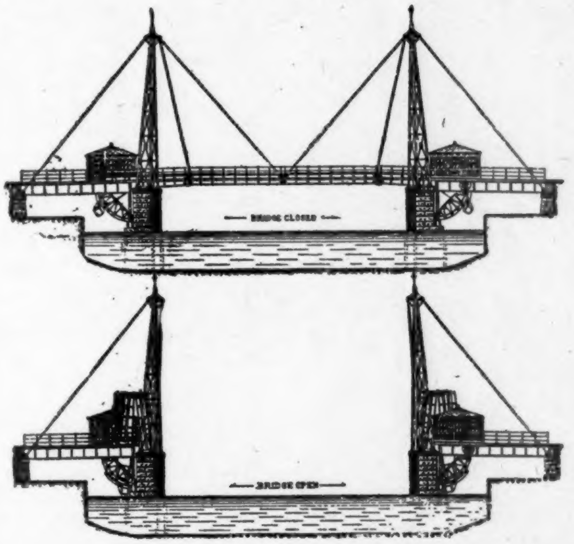
Business and political complications made last year a very unfavorable one for the Argentine lines, and their traffic and earnings show heavy decreases when compared with more prosperous years. Parallel lines and competition have

also begun to affect business, and the original faults of construction are becoming manifest.

STREET pavement of brick has been laid in Dunkirk, N. Y., at a cost varying from $1.60 to $2.37 per square yard, and experience has shown that it stands well under heavy traffic. Vitrified brick is to be used extensively in paving the streets of Toledo, O. There is no doubt that good brick presents many advantages for street paving.

THE steel rail mills are not very busy at present, the railroad companies having apparently held back their orders for the year as much as possible. There are few orders at present for rails for new construction, and while a large quantity will be needed for renewals, as usual, there is a delay in placing contracts.

A BRIDGE of the Harman pattern is now in use at the Weed Street crossing of the river in Chicago; it has a span of 60 ft., and another of 80 ft. span is to be built at the Canal Street crossing. As shown in the accompanying sketch, this is a double-jointed bascule or folding bridge, an outer joint permitting the end of the lifting leaf or panel to fold back. This requires a peculiar arrangement of the



HARMAN LIFTING BRIDGE, CHICAGO RIVER

counterweights. The advantages claimed for this form of bridge are that it requires less counterbalancing than an ordinary lifting bridge, is less likely to interfere with a ship's rigging, and offers less resistance to wind when open. On the other hand, it is somewhat more costly, and is necessarily less stiff than the ordinary lifting bridge of a single span.

ONE of the largest floating cranes in existence is now in use at the Cramp yards in Philadelphia; it is at present employed in placing the boilers, engines, and heavy armor-plates on the new cruiser *New York*. It is of the usual form of these cranes, a mast rising from a floating pontoon and steadied by a conical framework; this mast carries a horizontal arm or boom on which the traveler carrying the load works. The capacity of this crane is rated at 125 tons. The pontoon is of iron and is braced and divided into compartments by several bulkheads; it is 69 ft. long, 62 ft. wide, and 13 ft. deep. It is provided with capstans for moving itself when near a dock or other point where cables can be attached. When at work water can be let into some of the compartments to balance the weight of the load; pumps are provided to pump out this water rapidly.

The conical framework staying the mast is built up of steel plates and angles; it is 65 ft. high from the deck of the pontoon. The lower part is covered with a wooden framework forming a house in which are placed the four engines, of 40 H. P. each, which work the crane, and the boilers which supply the steam. The mast is of steel, is 3 ft. in diameter and is hollow; it extends 51 ft. above the framework, or 116 ft. above the deck of the pontoon. It rests in a socket on 42 steel balls, each 4 in. in diameter. Another set of ball bearings is placed at the top of the cone.

The lifting arm of the boom is 65 ft. long, and is stayed to the top of the mast by steel cables. The short arm is 50 ft. long, and from its outer end a steel stay, strongly braced, extends to the top of the mast; it is also anchored to the pontoon by heavy cables. The boom is of steel. The lifting arm has two sets of pulleys, one for heavy and one for light weights.

Separate drums and cables are provided for lifting, for moving the traveler backward and forward on the boom, and for swinging the boom around. The size of the crane and the length of the boom give it a considerable range of work.

THE American Steel Barge Company recently launched at West Superior, Wis., the whaleback steamer *Christopher Columbus*, which is to be fitted up as a passenger boat, to carry excursionists to Chicago next summer. The hull is of the ordinary whaleback type, and is 362 ft. long, 42 ft. beam, and 24 ft. deep. There are on this hull seven elliptical turrets which will serve to support a deck on which the main cabin and saloon will be built, and will also contain the communications between this cabin and the hold. The engines, boilers, crew accommodations, dining-room, kitchen and other offices are below, leaving the entire deck clear for passengers. The main cabin will be 225 × 30 ft., with a promenade all around it, and above this will be the texas or hurricane deck. The hull is divided into several compartments and can carry 750 tons of water ballast.

The *Christopher Columbus* will have a single propeller 14 ft. in diameter and 9 ft. pitch, driven by a triple-expansion engine with cylinders 26 in., 42 in., and 70 in. × 42 in. There are six steel Scotch type boilers 11 ft. in diameter and 12 ft. long, built for 160 lbs. working pressure.

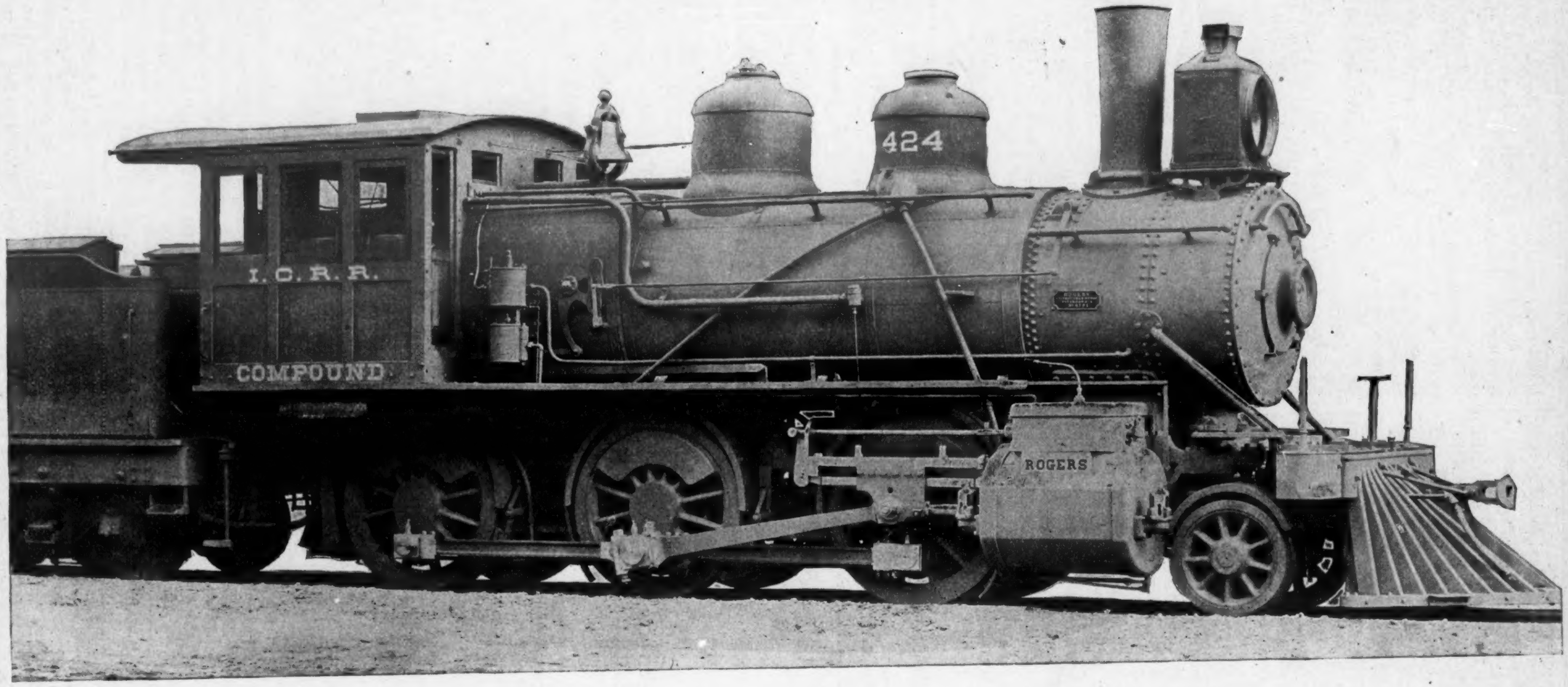
A NEW company has been organized and will ask the Connecticut Legislature for permission to build a dam across the Housatonic River near Oxford, Conn., where a fall of over 30 ft. can be obtained. The water-power will be used to operate dynamos and the power will be transmitted to the cities of New Haven and Bridgeport. It is believed that a profitable business can be done in supplying factories with power in this way. The distances from the site of the proposed dam to the cities named are less than those which have been successfully covered by electric transmission in Germany and Switzerland.

THE dam of the Honey Lake Valley Land Company at Long Valley, Cal., was carried away recently for the second time. The water rose rapidly after a heavy rain, and began to run over the crest of the dam, and in a few minutes cut out a gap 100 ft. wide. The accounts of the failure are not full, but it is said that poor construction and insufficient allowance for overflow had much to do with it.

THE total shipments of iron ore from the Lake Superior region by water during the season just closed were 8,485,210 tons; an increase of 32 per cent. over last year, and of 5 per cent. over 1890, which was a year of very large production. This does not include the rail shipments, which are not yet fully reported, but which are expected to reach 1,000,000 tons.

THE Chinese Viceroy Chang Chih-tung has established large iron works near Hankow, on the banks of the Yang-tse-Kiang River. Iron ore is brought about 80 miles down the river, and coal about 17 miles by a railroad lately built to the mines. At these works a rolling mill for the manufacture of rails is being put in, and they are also to be provided with the necessary tools for the manufacture of small arms and rapid-fire guns of different patterns.

THE surveys are in progress for an irrigation canal to run from Lake Tulare northward to the San Joaquin River near Mendota, Cal. The canal will be about 80 miles long, and will supply water for irrigation to a large area of land in the San Joaquin Valley. The intention is to use Lake Tulare for a storage reservoir.



TWO-CYLINDER COMPOUND LOCOMOTIVE FOR THE ILLINOIS CENTRAL RAILROAD.

BUILT BY THE ROGERS LOCOMOTIVE & MACHINE WORKS, PATERSON, N. J.; DESIGNED BY REUBEN WELLS, SUPERINTENDENT.

THE PRESENT STATUS OF THE UNITED STATES TIMBER TESTS.

THE examinations and tests of timber now in progress under the Forestry Division of the Agricultural Department, Washington, were suspended from January to July of last year from want of funds. Mr. B. E. Fernow, Chief of the Forestry Division, asked Congress, in a special bill, for an appropriation of $40,000 for this work. This was wholly disallowed in the House, but the Senate added an amendment to the department bill giving $12,000 to this investigation. This was finally cut down in conference to $4,000, which, with some additional funds from the general department appropriation, constitutes the working means for the current year. The work of testing was renewed in July, at the Washington University Testing Laboratory, St. Louis, under Professor J. B. Johnson, and the collectors are again in the field.

Tests of strength have now been made on specimens from 32 trees of long-leaf pine, 4 short-leaf pine, and 8 loblolly pine, all from Alabama; on 20 trees of white pine from Wisconsin, and on 34 different species of oak from Alabama.

Collections are now being made in Missouri, Arkansas, Texas, and Louisiana of short-leaf and long-leaf pine.

Results have been compiled for a bulletin on the strength of long-leaf pine, commonly known in the Eastern States as Georgia pine. Eleven of the 32 trees of this species tested had been bled or boxed—that is, they had been tapped for turpentine. This timber is usually excluded entirely from use in standard specifications, but the mills regularly saw and ship it, and claim no inspector can identify it. It is thought this bulletin will settle the question of the value of this bled timber so far as its strength is concerned.

Mr. William Kent, M.E., of New York, has been consulted as to the best plan to adopt in the analysis and publication of the vast mass of correlated facts brought out in these elaborate investigations, and how to compare the mechanical properties developed by the tests of strength with the physical properties found by the biologist, Mr. Philibert Roth, at Ann Arbor, Mich.

Between 5,000 and 6,000 tests of strength have now been made and a good foundation laid for future work. One bulletin describing the scope of the proposed investigation and the methods used, with illustrations of the machines employed, has been published and can be procured on application to Mr. B. E. Fernow, Chief of the Forestry Division, Agricultural Department, Washington, D.C. A great deal of interest in the work has been manifested, and many demands are already made for results. The first bulletin of results is delayed in order to fully mature a plan of publication which can probably be adhered to. After this has once been done the results will be given to the public more promptly.

Another special appropriation bill will probably be introduced into the next session of Congress for this work, and it is to be hoped it will fare better than its predecessor. There has been a wide demand for information concerning the strength of the famous Douglass, or Oregon fir, which is now coming into general use as far East as Chicago for bridge timbers especially, and of which Howe-truss railroad bridges are now built up to 250 ft. long. No information has been obtained as yet on this subject. If any of our readers are interested in learning more of the laws of the growth, strength, seasoning and preservation of timber they cannot do better than try to interest their congressmen in the work now so well started in the Forestry Bureau.

COMPOUND LOCOMOTIVE BY THE ROGERS LOCOMOTIVE AND MACHINE WORKS.*

ON another page we give a perspective view of a new compound mogul locomotive designed by Mr. Reuben Wells, Superintendent of the above works, and which has recently been put into service on the Illinois Central Railroad. It is of the two-cylinder type, with cylinders 20 and 29 in. diameter by 26 in. stroke. The driving-wheels are 56½ in. diameter; rigid wheel-base, 14 ft., and the total wheel-base, 21 ft. 8 in. long. The total weight of engine in working order is 128,500 lbs.; weight on driving-wheels, 107,100 lbs.

In our next number we hope to give a fuller description of the peculiarities which distinguish this machine from other compound locomotives of the two-cylinder type.

* The engraving is made from a magnificent photograph by Reid, 29 × 13 in size, unmounted copies of which may be obtained in this office, or will be sent by mail, postage paid, on receipt of the price, $2.75.

THE FIRST LOCOMOTIVE IN AMERICA.

THERE are a great many traditions afloat concerning the early history of locomotives in this country, and there is hardly an old road anywhere on which the claim is not made that it had *the* "first locomotive." It is the purpose of this article to give some really reliable history with reference to this somewhat mythical subject.

It has been related a great many times that in the beginning of the year 1828 the late Mr. Horatio Allen was commissioned by the Delaware & Hudson Canal Company to have built in England for the company three or four locomotives on plans to be decided by him when in England. In accordance with his instructions he made a contract with Messrs. Robert Stephenson & Company, of Newcastle-on-Tyne, for one locomotive, and with Messrs. Foster, Rastrick & Company, of Stourbridge, for three more. One of the latter was the *Stourbridge Lion*, which made the famous first trip on the Delaware & Hudson Canal Company's line at Honesdale, Pa., on August 9, 1829, with Mr. Allen as engineer. The story of this has often been told, and will not be here repeated again. Although the *Stourbridge Lion* made the first run in this country, it was not the first locomotive which arrived here. The engine built by the Stephensons, which was called the *America*, was in reality the first one to reach this country.

We are indebted to Mr. Clement E. Stretton, of Leicester, England, who has been an enthusiastic and interesting writer on the history of the locomotive, for the drawing from which our engraving herewith of the *America* was made, and also for the following description of the engine obtained from the Messrs. Stephenson, which was published in our November number, and is here reproduced:

DESCRIPTION OF LOCOMOTIVE ENGINE "AMERICA," BUILT BY R. STEPHENSON & COMPANY, FOR THE DELAWARE & HUDSON CANAL COMPANY, TO THE ORDER OF MR. HORATIO ALLEN, 1828, AND NO. 12 ON THE BOOKS OF THE MAKERS.

Diameter of boiler	4 ft. 1 in.
Length " "	9 " 6 "
Dimensions of fireplace	4 ft. × 3 ft.
Diameter of steam cylinder	9 in.
Length of stroke	2 ft. 0 "
Size of chimney	1 " 8 "
" " hot-water pump	1½ "
Stroke " "	2 " 0 "
Wheels (wood), diameter	4 " 0 "
Angle of cylinders to the horizontal	33°
Size of tubes	1 ft. 7 in.
Number of fire tubes	2

Tubes were straight.

The general plan of the engine was very similar to that of the *Lancashire Witch*, which was built by the Stephensons in 1828 for the Bolton & Leigh Railway.

The following extracts, taken from correspondence preserved in the office of the Delaware & Hudson Canal Company, fix the date of the arrival of this engine, built by the Stephensons, and also shows that Foster, Rastrick & Company were very dilatory in the delivery of the three which they built, among which was the *Stourbridge Lion*. As a bit of authentic railroad history it will, it is thought, interest many of our readers. The curious part is the fact that no trace can now be obtained to indicate what became of the Stephenson engine. Before his death, Mr. Allen stated that one of the engines was set up in the iron yard of Abeel & Dunscomb, in New York, and was raised up so that the wheels were clear, and the engine was then run with steam and publicly exhibited. Whether this was the Stephenson engine or one of the others is now uncertain.

The correspondence, however, establishes beyond doubt that the *America* was the very first locomotive on this side the Atlantic.

EXTRACTS FROM CORRESPONDENCE IN OFFICE OF THE DELAWARE & HUDSON CANAL COMPANY.

S. Flewwelling, Treasurer, to John Bolton. Dated New York, January 17, 1829.

"The locomotive engine made by Stephenson & Company has arrived, and I regret that Mr. Allen is not here to direct about taking it from the ship and placing it in a proper situation for putting it up."

S. Flewwelling, Treasurer, to John B. Jervis. Dated New York, January 20, 1829.

"The locomotive engine made by Stephenson & Company, which is the most expensive one, has arrived."

S. Flewwelling, Treasurer, to W. & J. Brown & Company (of Liverpool). Dated New York, February 7, 1829.

"The locomotive engine shipped by your request by Edward F. Starbuck, agent from London, on board the ship *Columbia* in November last has been received."

S. Flewwelling, Treasurer, to W. & J. Brown & Company (of Liverpool). Dated New York, March 6, 1829.

"Mr. H. Allen, when in England, contracted with Messrs. Foster & Rastrick for three locomotive engines, which were to have been shipped shortly after he sailed for this country. As a considerable time has elapsed since we had reason to expect their arrival, and it being very important that they should be sent on as early as possible, I have to ask the favor of you to inquire of Messrs. Foster & Rastrick when these engines will be forwarded, and that you will be pleased to inform me of the result of your inquiry.

"Mr. Allen is now in the country. Had he been here I would have requested him to write to the makers direct."

S. Flewwelling, Treasurer, to Messrs. W. & J. Brown & Company (of Liverpool). Dated New York, April 23, 1829.

"On the 6th of March last I wrote you, requesting you to inquire of Messrs. Foster & Rastrick when the three locomotive engines ordered by Mr. Allen last fall would be completed, and to inform me of the result of your inquiry. They have been expected by every ship that has arrived here from Liverpool for some months, as one of them was nearly completed when Mr. Allen left England in October last, and the two others were to have been finished, and the whole shipped in a short time after his departure, and we are greatly disappointed in their not having yet arrived. The reasons for this delay we are unable to account for, but it is certain the makers have not performed their contract. I have to request that you will immediately employ a competent person, at our expense, to go to Messrs. Foster & Rastrick and insist upon the three locomotive engines ordered by Mr. Allen being finished with all dispatch, and to superintend and see that they are made in the shortest time possible and forwarded to you, that they may be shipped for this place immediately thereafter.

"You will perceive the necessity for my urging your particular attention to this business when you are informed of the importance of the work on which these engines are to be employed. They are for the transportation of coal on our railroad which is the principal article to be conveyed on our canal of 105 miles in length. The canal is finished, and the railroad with its machinery is expected to be completed early in the month of June next. Without the locomotive engines the whole will be in a great degree inoperative, and all delay in receiving them after the other part of the work is ready for the transportation of the coal will be the loss of the income from a work which will have cost upward of two millions of dollars."

John Bolton to John B. Jervis. Dated New York, May 13, 1829.

"One of the locomotives was to be shipped in the *John Jay*, then in Liverpool, and she is daily expected. The other two are promised, one in 3 and the other in 5 weeks from 8th April. They pretend that an accident to their works has caused the delay. So I yet hope they may reach us in time."

John Bolton to W. & J. Brown & Company (of Liverpool). Dated New York, May 14, 1829.

"I have the pleasure of acknowledging your favor of the 16th ulto. covering a letter from Messrs. Foster, Rastrick & Company, of the 8th, assigning reasons for the delay in execution of their contract for steam-engines, and fixing the time for their deliverance. I trust they will perform their new engagement strictly, but the slight manner in which they notice the lapse of 5 months since the time they engaged to make the delivery does not, I confess, afford strong ground of confidence. Our work is now nearly ready to receive the engines, and so great would be the sacrifice if disappointed that we had determined on sending Mr. Allen out immediately, and should have done so by this packet if I had not received your favor of the 16th. . . . .

"The *John Jay* arrived yesterday with one of the steam-engines."

S. Flewwelling, Treasurer, to Messrs. W. & J. Brown (of Liverpool). Dated New York, May 15, 1829.

"By the arrival of the *John Jay* we have received one of the locomotive engines, and your account is credited £498 18*s*. 3*d*. for the amount of the invoice and the insurance notes enclosed in your letter to the President of the 7th ulto."

W. & J. Brown & Company to John Bolton. Dated Liverpool, May 22, 1829.

"By the packet of 16 ult. we wrote you, and handed a copy of a letter from Messrs. Foster, Rastrick & Company, stating that one engine would be sent off in three weeks, and the other in five weeks or sooner if possible. Their letter was dated 8th ult., but six weeks have now elapsed, and we have no further accounts of them. We have again written to these gentlemen requesting to know distinctly what we are to expect; and if their reply is not entirely satisfactory, we will, as you suggest, send a competent person to their works to see that no further unnecessary delay takes place."

S. Flewwelling to John Bolton. Dated New York, June 23, 1829.

"The two canal boats arrived here on Sunday, and one of them has been left at the dock near Kimble's; the other was to be taken round to Abeel & Dunscomb's to-day. Mr. Allen understood from Mr. Jervis that the locomotive engines were not to be sent up until the breach at the Pulpit (?) was repaired, of which Mr. Jervis was to advise him; and thinks if they are sent this week, the boats will be delayed some time with the engines in them."

S. Flewwelling to John Bolton. Dated New York, July 1, 1829.

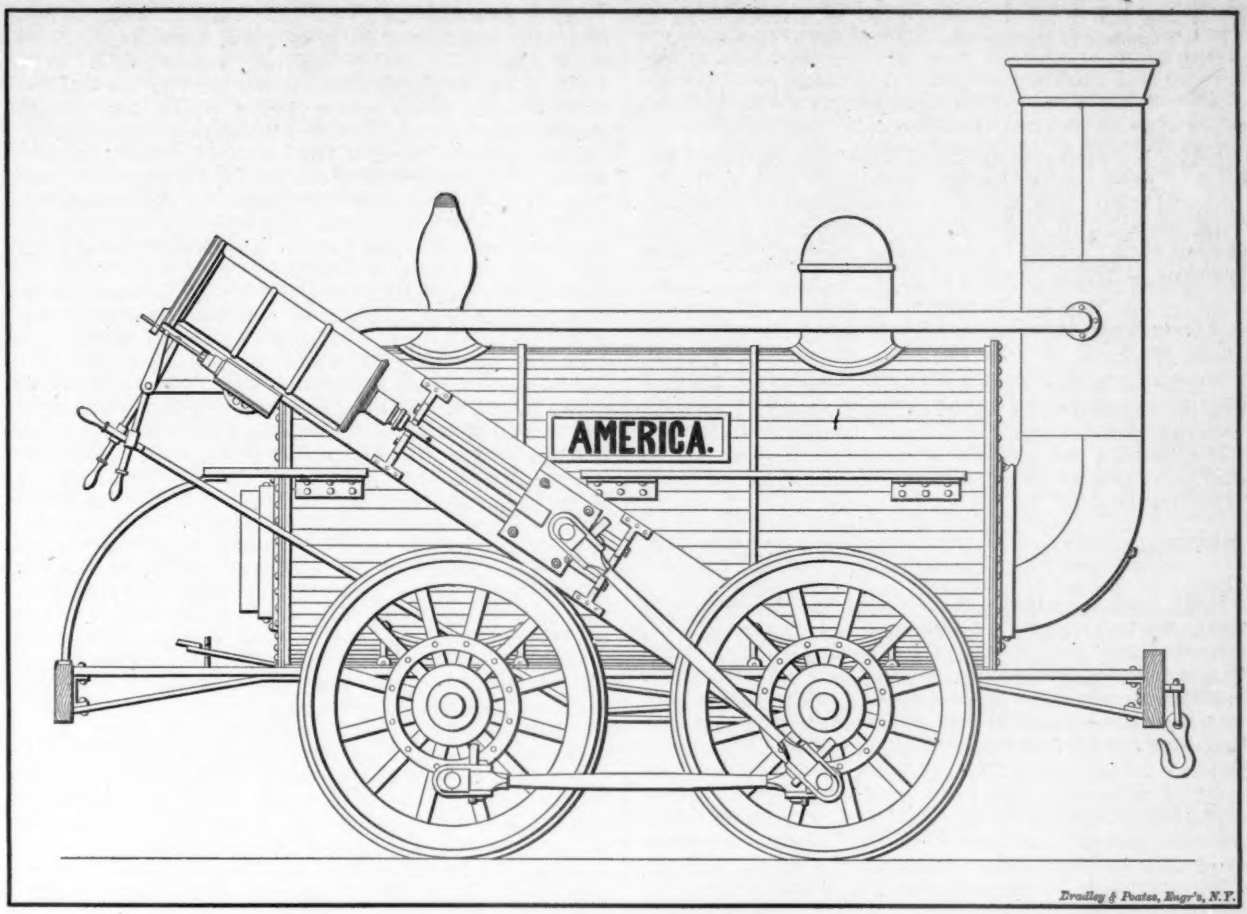
"The locomotives will be put on board the *Congress* tomorrow, and the canal boat will be loaded with wheels, and (?) towed up."

S. Flewwelling to John B. Jervis. Dated New York, July 2, 1829.

"Mr. Allen is putting the locomotive engines on board the *Congress*, that goes up to-day, and he goes on her to Kingston."

S. Flewwelling to J. B. Jervis. Dated New York, July 22, 1829.

"By the arrival of the *Britannia* I have just received a letter from Messrs. W. & J. Brown & Company, of Liverpool, in which they say: 'We have received from Messrs. Foster, Rastrick & Company an invoice for the 2d locomotive engine—amt. £488—which they inform us has been sent off, and we have no doubt it will be here in time for shipment by the packet of 8th proxo. The other, they say, will be forwarded in ten days.' That letter from W. J. B. &



LOCOMOTIVE ENGINE "AMERICA."

BUILT BY R. STEPHENSON & COMPANY, NEWCASTLE-ON-TYNE, FOR THE DELAWARE & HUDSON CANAL COMPANY, TO THE ORDER OF MR. HORATIO ALLEN, IN 1828.

Company is dated the 29 May, and the packets of the 8th and 15th of June are daily expected which may bring both of the engines."

S. Flewwelling to J. Bolton. Dated New York, July 29, 1829.

"We are again disappointed in the locomotive engines not being on the *Silvanus Jenkins*. A letter of the 8th of June from W. & J. Brown & Company says:

"'The locomotive engine has been here several days; but the packet having had but little time to load we could not induce the Cap't to take it owing to the difficulty of getting it on board. We then engaged to ship it by the *Thos. Dickerson* to sail 12th inst., but the master has just called to say that in measuring his hatchway he finds the boiler is too large to go down it, and we shall now endeavor to get it on board the *New York*, to sail 16th inst.'"

S. Flewwelling, Treasurer, to J. Bolton. Dated New York, July 31, 1829.

"The *New York* has arrived without the locomotive engine, but letters are received from Messrs. Brown, saying that it is on board the *Splendid*, to sail on the 20th June."

S. Flewwelling, Treasurer, to J. Bolton. Dated New York, August 3, 1829.

"I omitted to mention that a copy of a letter from John U. Rastrick was enclosed in the letter rec'd from W. & J. Brown & Co., in which he says:

"'The last engine would have been sent off last week, but as I have made some very important additions and improvements to our locomotive engines that we started the 2d inst., I determined to alter the one on hand; we are now adding these, and I shall also send the additional parts for the two engines already sent off free of any additional charge, being desirous to make them as perfect as possible, and when I have written Mr. Allen, from whom I have had a letter, and sent him the drawings and details, I know he will feel I have done everything for their advantage, and that the delay of a few months will be amply compensated for by the improvements of the engines. I will send the whole off in ten days.'" (*Dated June* 13, 1829.)

S. Flewwelling, Treasurer, to Messrs. W. & J. Brown & Company (of Liverpool). Dated August 7, 1829.

"In the copy received of the letter from Messrs. Foster & Rastrick they give a reason for the delay in completing and forwarding the locomotive engines, which they appear to hope will be satisfactory. They cannot, however, be insensible of the great responsibility they have assumed in extending the time six months beyond the period at which they contracted to deliver them; and it is a subject of surprise that they should conceive any improvement made in the engines could warrant or excuse so great a delay in their delivery.

"The engine shipped on the *Splendid* has not yet arrived, and at present we cannot calculate the injury we may sustain from the delay."

S. Flewwelling, Treasurer, to W. & J. Brown & Company (of Liverpool). Dated August 15, 1829.

"The locomotive engine, by the ship *Splendid*, is received with your letter of the 19th of June last, covering invoice

and bill of lading; and your account is credited £503 2*s.* 7*d.*, the amount of the invoice and the cost of insurance."

S. Flewwelling, Treasurer, to John Bolton. Dated September 6, 1829.

"The locomotive engine is on board the *Cornelia;* but could I have known that she would have been so deeply loaded, I should have sent it by the steamboat on Thursday. Capt. Goetchies (?) says there is no hazard; but I shall feel anxious until I hear of its safe arrival, although the wind is moderate, with the prospect of its being fair."

S. Flewwelling, Treasurer, to M. Wurts, Agent. Dated September 12, 1829.

"The day before yesterday a report was circulated here that the locomotive engine called the *Lion* had by accident been run off the railroad and dashed in pieces. I am glad you mentioned the accident of the wagon running off the road, as it gave me an opportunity of explaining the cause of the report."

S. Flewwelling, Treasurer, to John Bolton. Dated New York, September 15, 1829.

"Mr. Lord has returned, and says he had the pleasure of seeing you at Kingston. All the persons with whom I have conversed, who have witnessed the moving of the locomotive engines on the railroad, say that they cannot perceive that the iron plates are pressed out of place so as to be any way injurious, and could not discern any damage which they considered important, even after it was pointed out to them."

S. Flewwelling to John Bolton. Dated New York, September 18, 1829.

"The *John Jay* arrived yesterday, and brings the last locomotive engine. When landed, I shall send it up unless instructed to the contrary."

S. Flewwelling to John Bolton. Dated New York, October 21, 1829.

"Mr. Dunscomb has put the boiler of the locomotive engine on board the sloop *Forrester*, Captain Betts."

CONTRIBUTIONS TO PRACTICAL RAILROAD INFORMATION.

Chemistry Applied to Railroads.

SECOND SERIES.—CHEMICAL METHODS.*

I.—PHOSPHORUS IN STEEL—*Continued.*

By C. B. Dudley, Chemist, and F. N. Pease, Assistant Chemist, of the Pennsylvania Railroad.

(*Continued from page* 550, *Volume LXVI.*)

With regard to the method given in the last number, a few words in explanation of the reasons why certain modes of procedure and certain reagents were chosen, rather than others which are likewise in use by good chemists, may perhaps not be amiss.

We have no doubt that many chemists will think that one gram is a small amount to work on, and would prefer to work on a larger amount of steel, thus reducing the possible error. Our decision to use one gram is based on this. There is a belief, possibly not fully demonstrated, that the complete separation of phosphoric acid from iron is difficult, if not quite impossible, by means of molybdic acid. When we say complete separation we mean the very last and most minute trace. If our memory serves us correctly, eminent chemists have affirmed that such separation was impossible; and the published work of Dr. J. Lawrence Smith—notably his article in the *American Journal of Science*, third series, Vol. XXII, p. 316—seems to indicate that the separation of phosphoric acid from iron is most complete when the proportion of molybdic acid to the iron in the solution in which the yellow precipitate is formed is large. Furthermore, we made this experiment—namely, we took a neutral water solution of chloride of iron and a neutral water solution of molybdate of ammonia, and on mixing these a precipitation ensued of apparently white molybdate of iron, which precipitate is readily soluble in nitric acid. We are inclined to think, therefore, that when the molybdate solution is added to the iron solution in the regular phosphorus determination, molybdate of iron is formed, and that the chances of a complete separation of phosphoric acid are greater, provided the amount of molybdic acid is sufficient to convert all the iron into molybdate. But with the molybdate solution at present in use this result cannot be accomplished without an excessive amount of the molybdate solution, and a very large dilution of the menstruum in which the yellow precipitate is formed, if we start with 2 grams of steel. With the method as we have given it the amount of molybdic acid in the 75 cubic centimeters of molybdate solution is sufficient to convert all the iron into molybdate, and leave a quite considerable excess of molybdic acid to combine with the phosphorus. There are some indications that low results when using the molybdate method may be explained in this way—namely, starting with 5 or 10 grams of steel and only adding the ordinary amount of molybdate solution, the separation of phosphoric acid is possibly not complete. Another series of experiments which we tried also proved instructive. We took a certain amount of nitrate of iron solution containing phosphorus and added 5 cubic centimeters of molybdate solution which contained twice as much molybdic acid as was necessary to precipitate all the phosphorus, everything being done to secure the most favorable conditions for the formation of the yellow precipitate. No yellow precipitate was formed in some time. We then added 5 cubic centimeters more without any precipitation, and so proceeded until we had added 25 cubic centimeters, when the precipitate began to form, and ultimately all the phosphorus came down. Another series with the normal amount of nitrate of ammonia present before adding the molybdate solution showed similar results. Apparently, therefore, a certain amount of molybdate solution, in excess of what is necessary to form the yellow salt, is essential before the yellow precipitate will form in presence of nitric acid and nitrate of iron. Just exactly where the limit is it would require further work to demonstrate; but in view of the uncertainty, we decided on such proportions of metal to start with and of molybdate solution as would convert all the iron and still leave enough molybdate to combine with the phosphoric acid. One consideration further, the permanganate solution given in the method above is of such strength that even though an error of 0.10 cubic centimeter should be made in the readings at the final titration of the molybdic acid, the error introduced by this 0.10 would be but a trifle over 0.0005 per cent. Since, therefore, it is easy to read burettes as close as 0.10, we are inclined to think that the error introduced, even in steels very low in phosphorus, by working on one gram can be safely ignored.

It will be noted that, in the course of the method as described, it is stated that the specific gravities of the solutions are essential. It seems to be generally agreed that the concentration of solutions, the bulk of the solutions, the temperature of precipitation, the amount of free acid present, and also the amount of other salts present, all have an influence on the composition of the yellow precipitate, also that if these conditions are made constant, a yellow precipitate of constant composition or practically so is obtained. It would be, perhaps, too much to say that we have ourselves made experiments to demonstrate each one of these points. We find these points claimed, with more or less demonstration accompanying them, in the literature of the

* The first series of these articles was published in The Railroad and Engineering Journal, December, 1889-June, 1892. The present article is the third of a new series; the first of these was introductory, the second on the same subject as the present one.

method, and our experience is limited more especially to the last clause—namely, if we make the conditions constant we have no difficulty in getting uniform results working on the same steel. Duplicate, triplicate and quadruplex determinations on the same steel, on different days, and with different steels, rarely differ more than 0.002 per cent. or 0.003 per cent. on very low steels, provided the directions are carefully followed and the conditions made uniform. Many duplicates show the same result even to 0.001 per cent. It is only, however, by having all the conditions constant that such results can be obtained, and this is why so much importance is attached to the specific gravities of the solutions. It is very interesting to note that dilute nitric acid, even so dilute as 1.135 specific gravity, gives exactly the same results as if concentrated nitric acid was used for the first solution, as we have proven by duplicate determinations on the same sample, using the different gravities of nitric acid to start with. It seems probable that the reaction between the steel and the nitric acid is a complicated one, resulting in the formation of several products. Apparently one of the first reactions, especially if dilute acid is used, is to form a proto-nitrate of iron. The subsequent boiling of the solution after the steel is dissolved converts this, with decomposition of some of the free nitric acid, into the sesqui-salt; and if this boiling is carried out as the directions state, much less of the permanganate will be used in the subsequent oxidation than if the solution is not boiled. It is barely possible that the action of the permanganate may not be completely understood, and there seems a threefold action possible: first, to convert any proto-nitrate of iron that may be left, into the sesqui-salt; second, to oxidize the carbon in the nitric acid solution; and, third, to completely oxidize the phosphorus to phosphoric acid. It is believed that the directions cover the complete oxidation for all steels, but it is obvious with steels containing large amounts of carbon, such as spring steel and tool steel, more oxygen will be used up from the nitric acid and permanganate than from steels containing small amounts of carbon.

The desirability of securing the necessary oxidation of the iron salt and of the carbon, and possibly of the phosphorus to phosphoric acid, by permanganate rather than chromic acid, is a question about which there may be some difference of opinion. In our experience the permanganate seems to accomplish the result fully as satisfactorily as the chromic acid, and does not introduce any free acid into the solution. We have not made exhaustive experiments on the use of these two oxidizing agents, but the method which is especially characterized by the use of chromic acid requires evaporation, which is not essential in the method which we have recommended. Moreover, as will be stated a little later, the amount of free acid present we think has an influence on the composition of the yellow precipitate, and possibly on the amount of it; so that since we can secure the result desired by the addition of the neutral salt, we think it safer and better in every way to do this than to use the free chromic acid. This peculiarity—namely, the use of permanganate instead of chromic acid—is one of the principal differences between the method as we recommend it and Wood's method, which has already been published and largely used. This perhaps is the place to give another reason why we prefer the method as published to Wood's method—namely, in addition to the greater ease and equal certainty obtained by the use of permanganate, we are inclined to think the method that we recommend gives more readily obtained constant conditions than Wood's method. With the latter a certain amount of evaporation to approximately certain bulk of the nitric acid solution is requisite. In our experience, covering now two or three years, we find it very difficult to get uniform conditions as to free nitric acid present with this evaporation. The evaporation itself is a disagreeable operation, is conducted in a beaker not capable of accurate measurement, and results in very concentrated nitric acid, so that a small error of bulk makes a wide difference in the amount of free nitric acid present in the subsequent operation. We have obtained excellent results with Wood's method, but we think the labor and uncertainty of the method are greater than of the method which we recommend.

The amount and strength of the nitric acid used to dissolve the steel and the subsequent manipulation and use of the solution have been designed in such a way that after the molybdate solution is added the percentage of free nitric acid in the resulting solution is the same as in the molybdate solution itself. Our reasoning was this: It is believed that the yellow precipitate is more insoluble in the molybdate solution than in any other known menstruum, and the insolubility of the yellow precipitate is affected by the amount of free nitric acid. We therefore base our quantities and manipulation so as to secure a final solution in which the yellow precipitate should be formed that would have the same amount of free nitric acid as the molybdate solution. Of course if a molybdate solution can be made in which the yellow precipitate is more insoluble than the one given in the method as published, it would be a step forward. At present, and until further work is done on this point, our method as published rests, so far as the insolubility of the yellow precipitate is affected by free nitric acid, on the amount of free nitric acid in the standard molybdate solution. We of course recognize that the nitrate of iron may have an influence on the insolubility of the yellow precipitate, and our only point here is that, as stated above, so far as the insolubility of the yellow precipitate is affected by the free nitric acid, the method as given assumes that the molybdate solution contains that amount of free nitric acid in which the yellow precipitate is most insoluble.

Those who are familiar with the literature of phosphorus determinations will remember that it has been recommended to reduce the molybdic acid in a flask or beaker by treatment with granulated zinc, and it will be observed that instead of this procedure, we pass the liquid through a reductor containing powdered zinc. We have used both methods, and our experience very greatly favors the reductor method with the powdered zinc. Even with platinum and a little mercury present for amalgamation, the very last portion of the reduction is extremely slow with granulated zinc, and it is difficult to completely discharge the port-wine color. Even a few minutes' standing after the liquid is poured off from the granulated zinc before titration will give this color, indicating incomplete reduction of the molybdic acid. On the other hand, with the reductor the reduction is apparently complete within the first half inch of the powdered zinc in the top, and we have never had the slightest difficulty with any subsequent oxidation. We have run across some parties who claimed that they did not get good results with the reductor, but this is so contrary to our experience that it is difficult for us to see why. We will say, however, that if the yellow precipitate is washed in nitric acid, or in a wash-water containing nitrates, or if all the nitrates are not washed out of the yellow precipitate, there will be trouble subsequently with the reductor. The deleterious effects of nitric acid can be readily demonstrated by any person for himself, by adding a drop or two of nitric acid to dilute sulphuric acid, and passing it through the reductor simply as a blank, followed by subsequent titration. Of course, when nitrates are treated with sulphuric acid, free nitric acid results, producing the same effect. The amount of permanganate used up by even a single drop of nitric acid, under the conditions above, will, we think, astonish any one who has not made the experiment.

It is probable that many chemists will prefer to dry and weigh the yellow precipitate instead of titrating with permanganate, as we recommend, and it is only fair that the reasons which led us to choose the permanganate method should be given. There are two reasons. We may say preliminarily that we have obtained almost identical results by both methods, but in our experience the weighing of any substance on the dried filter is always an operation attended with uncertainty, especially unless one has had a good deal of experience. We have also obtained very satisfactory results by catching the yellow precipitate in a Gooch crucible on an asbestos filter, but find at the best that the gradual change of a dried filter, or a Gooch crucible, during the operation of weighing, is sufficient in our experience to introduce a little feeling of uncertainty as to results. There is another consideration which has some influence here—namely, in steels containing 0.20 to 0.30 of silicon there is always a danger of weighing a little silicon with your yellow precipitate. In view of these uncertainties and in view of the fact that almost every laboratory has or should have a standard permanganate solution which can be easily stand-

ardized and easily kept standard, we finally decided, after a good deal of study and thought, to use the permanganate method. If the reductor is kept in good order and the laboratory has a supply of standard steel or iron, proper care being taken to secure good permanganate of potash and to age it properly before it is used, there are few reagents, if we may trust our experience, that are more satisfactory than permanganate solution.

The end reaction in washing the yellow precipitate may possibly need a word or two of explanation. It will be observed that the directions practically require to allow a few drops of the washings from the funnel to fall into a dilute sulphide of ammonium solution. The wash-water is acid, and the sulphide of ammonium more or less alkaline. It is obvious, therefore, that there may arise two conditions. Enough wash-water may run in to change the sulphide of ammonium solution into an acid solution, or only enough washings may run in to still leave the sulphide of ammonium alkaline or neutral. Under which condition is the greater sensitiveness obtained? Some chemists prefer the acid condition; but our directions call for the alkaline condition, which we prefer, and for the following reason: If we are testing for molybdenum, it is obvious that the acid solution should be used, since molybdenum forms no precipitate in the alkaline solution, but simply changes color slightly. If we are testing for iron, no precipitate or change of color is formed in the acid solution, but a marked change of color results in the alkaline solution. In view of the fact that the yellow precipitate is believed to be slightly soluble in the wash-water if we test for molybdenum, it is obvious we would never get an end reaction, provided the test is sufficiently delicate. On the other hand, we are washing out of the filter molybdate of iron, and when the molybdate of iron is out it is perhaps safe to assume that the filter is washed clean. We accordingly prefer that manipulation which shows the iron, especially since the molybdenum present assists the change of color, even in the alkaline solution.

The use of sugar and other organic substances to reduce the binoxide of manganese formed during the process of solution and oxidizing the phosphorus has been proposed. It will be observed that we prefer to use proto-sulphate of iron. It is claimed that there is not much difference between the action of these various substances; and as the amount is quite small, it is probable that the results will not be seriously affected whichever reducing agent is used. We prefer the proto-sulphate of iron, as we do not like to introduce into a steel solution, where we have been trying to get rid of the organic matter, any organic substance. Of course a very large amount of sulphate of iron might produce sulphates enough to interfere with the successful subsequent precipitation of the yellow precipitate, but there seems little danger of this if the directions are followed.

Some questions may arise in regard to the calculations. There is a good deal of variation in the literature of the phosphorus method as to the composition of the yellow precipitate. Our own explanation of these variations is that probably the composition of the yellow precipitate is affected by the conditions under which it is formed. Our figure showing the relation of phosphorus to molybdic acid was obtained as follows: We took three samples of steel, one containing about 0.15 per cent. carbon, one containing about 0.55 per cent. carbon, and another containing about 1.00 per cent. carbon. We made careful phosphorus determinations on each of these three samples by what is known as the combination method—that is, starting with 10 grams, we separated arsenic, and proceeded exactly as described under the acetate method in the "Chemical Analysis of Iron," by A. A. Blair (second edition), up to the point of obtaining the basic acetate precipitate, except that instead of adding two or three drops of bromine to oxidize iron enough to carry down the phosphorus, we added enough bromine to oxidize one-half gram of the iron. This half gram, after being washed on the filter, was treated with nitric acid and the phosphorus separated from it by means of molybdic acid. The yellow precipitate obtained from this precipitation was then dissolved in ammonia and the molybdic acid converted into the sulphide in alkaline solution by passing sulphuretted hydrogen gas, after which the molybdic acid was separated by acid and removed by filtration. In the filtrate concentrated to a very small bulk, the phosphorus was precipitated by magnesial mixture. The results obtained from these analyses were regarded as the amount of phosphorus contained in the three steels, and the factor used in the volumetric method was based on these analyses.

Within the last year a method of treating the yellow precipitate different from that which we recommend was published by Mr. J. O. Handy, Pittsburgh, which consisted practically in dissolving the yellow precipitate in caustic soda, and titrating the excess of soda by means of nitric acid, using phenolphtaline as the indicator. This method has been received with a good deal of favor, and, according to our experiments, gives practically the same results as the method which we recommend. Two reasons, however, led us not to adopt this in preference to the permanganate treatment of the yellow precipitate: first, it is more difficult to secure standard solutions of caustic soda and nitric acid than it is to secure a standard solution of permanganate of potash. Starting with metallic iron, the strength of the permanganate solution is easily and quickly obtained, and the same solution is used in almost every laboratory for other purposes. The Handy method requires the maintenance of two special solutions not useful for other purposes. There is another phase of the case—namely, phenolphtaline is not delicate in presence of ammonia salts; and while the solutions can be so manipulated that this difficulty is small, provided the amount of yellow precipitate titrated is small, we are inclined to fear that with high phosphorus, considerable difficulty would result; so we really saw no advantage in this over the permanganate method, while what advantage there is seems to be the other way, and accordingly we chose the permanganate method.

Also during the past year Mr. H. C. Babbitt, Chemist of the Wellman Iron & Steel Company, Thurlow, Pa., proposed a modification of the method of getting the yellow precipitate, which is claimed to eliminate the co-precipitation of the arsenic with the phosphorus. The method consists practically in precipitating at a temperature not above 25° centigrade. We think it has been taught in some of the schools for a considerable time past that the chances for carrying down arsenic along with the phosphorus by means of molybdic acid were diminished at low temperatures, but it has also been taught that in order to secure a complete precipitation of the phosphorus under these circumstances it was essential to have considerable time. Mr. Babbitt's paper would seem to claim that even at low temperatures and short time, phosphorus might be completely precipitated with the avoidance of the co-precipitation of the arsenic. We have not been able to do much positive work on this question. A little work on a single sample of steel known to contain quite considerable arsenic with considerable phosphorus, does not confirm the view that the phosphorus is completely precipitated at low temperatures and in short time. Further work should be done on this point, and it is fair to say that the question of how to secure the phosphorus in steel by any rapid method without the arsenic interfering, so far as our knowledge goes, is not at present satisfactorily answered. In view of this state of affairs, we decided to take the other horn of the dilemma—namely, to call all that comes down by the method which we have published phosphorus, recognizing at the same time that in steels containing considerable arsenic there is a strong probability that a portion of the material called phosphorus is arsenic. It is barely possible that within the next six months or a year some method of overcoming this difficulty may be devised. It is to be regretted that there is so little positive knowledge of the influence of arsenic on steel. The best authorities that we can consult indicate at least that arsenic is not so harmless an element in steel that it can be ignored, also that its influence is much the same as that of phosphorus; so that, in view of the fact that the steel-makers are forewarned that arsenic will be counted against them, we think no hardship can result.

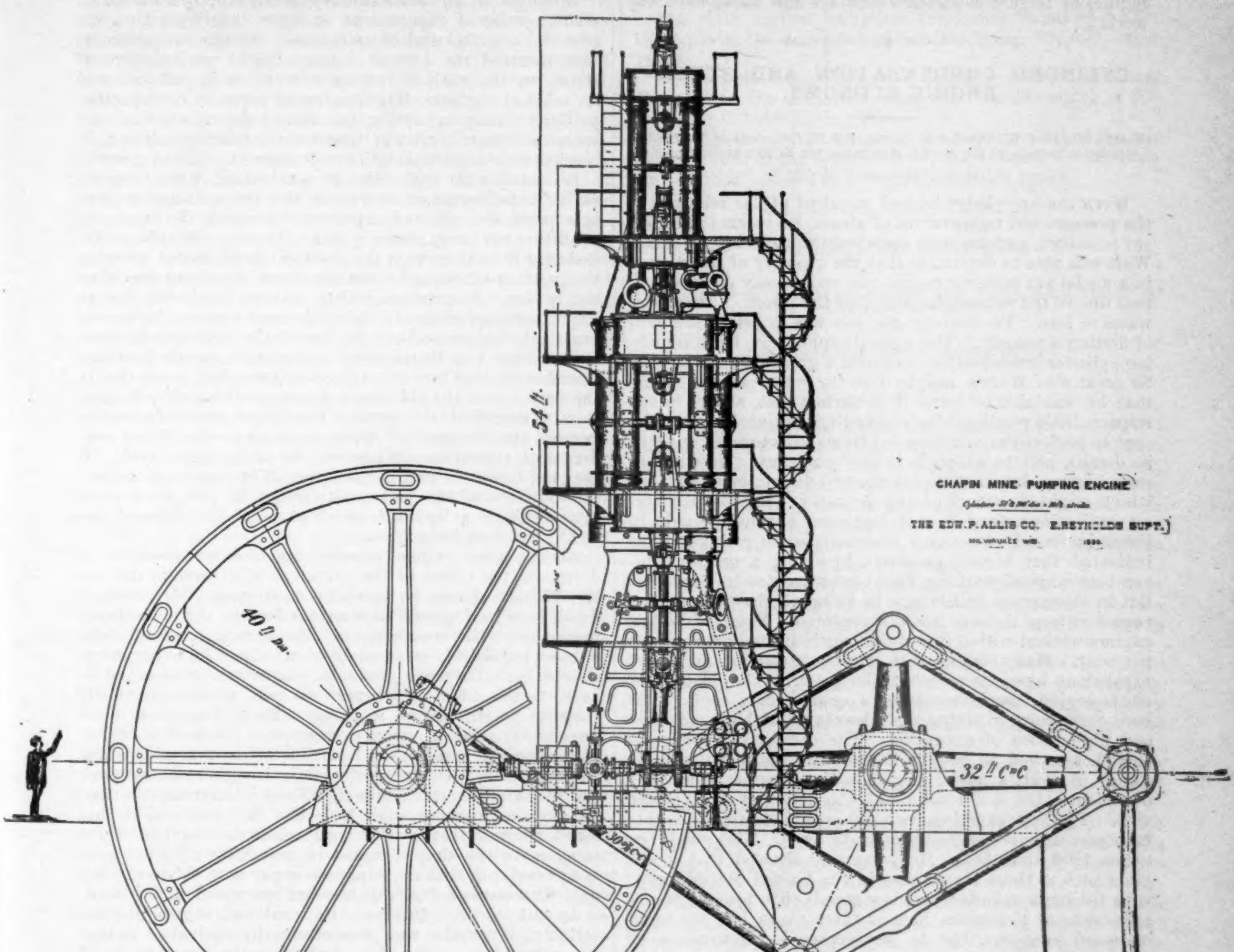
It will be observed that the method as published is not recommended to be used for pig iron, nor have we experimented with it on ores. It is to be hoped that enough work will be done in the near future to not only check up whatever weak points there may be in the method as it now exists, but also to expand its application.

(TO BE CONTINUED.)

A LARGE PUMPING ENGINE.

THE engraving given herewith is from a drawing of an engine which is notable not only for its large size, but also for the special adaptation of its design to the work which it is intended to do. It was recently built by the Edward P. Allis Company in Milwaukee, Wis., for the Chapin Mining Company of Iron Mountain, Mich. It is a compound type. The cylinders have poppet valve-gear with a trip cut-off on the high-pressure cylinder and a Stevens cut-off on the low-pressure cylinder. There is an independent steam-power air pump and a surface condenser; in the latter, part of the water raised from the mine will be used for condensing purposes.

A peculiar feature of this engine is that the cylinders and valve-gear are so proportioned and arranged that the engine can be run by compressed air instead of steam, if de-



engine of the steeple pattern and is designed to raise water up a vertical shaft from a depth of 1,500 ft.

The work will be done by plunger pumps placed in the shaft about 200 ft. apart. These pumps have plungers 28 in. in diameter and 10 ft. stroke; the plungers are connected and driven by a steel rod 7 in. in diameter extending to the bottom of the shaft and working in guides placed about 20 ft. apart. At its upper end this driving-rod is connected to the beam shown in the engraving, from which it receives a reciprocating motion, and which is, in turn, driven directly by the engine.

As before noted, the engine is of the compound type; the high-pressure cylinder is 50 in. in diameter and 10 ft. stroke, and the low-pressure cylinder 100 in. in diameter and 10 ft. stroke. The ratio of the cylinders is 1 : 4. The engine is designed to work with 125 lbs. pressure. Steam will be supplied by vertical tubular boilers of the Reynolds

sired. In running with air the large or low-pressure cylinder would be used as the initial cylinder. The Chapin Company has a plant of large capacity at Quinnesec Falls, where air is compressed by water-power, and from this plant the engine can be supplied, should it be decided to dispense with steam.

The great size and capacity of the engine will be better understood from some of the details. The journals of the main shaft and of the beam centers are 24 in. in diameter and 36 in. long. The crank-pin, crosshead-pin, and the pins on the beam have bearings 16 in. in diameter and 18 in. long. The connecting-rod is 30 ft. in length and is 15 in. in diameter at the center. The fly-wheel is 40 ft. in diameter and weighs 160 tons. The main beam is 32 ft. between centers, and its weight complete is 100 tons. The total weight of the engine, including only the parts shown in the engraving, and excluding the pumps and other work

in the shaft, is 600 tons. Its total height above the engine-room floor is 54 ft. It is one of the largest stationary engines in the country and is expected to do notable work.

This engine is all in place and erected at the mine, and will be started up as soon as the work on the pumps in the shaft is completed. The depth of the main shaft of the mine is now 600 ft., and three sets of pumps are in place. Additional pumps will be added as the shaft is sunk deeper.

The works of the Allis Company have turned out many engines of large dimensions which are now doing excellent work.

CYLINDER CONDENSATION AND STEAM-ENGINE ECONOMY.

(From address of W. Cawthorne Unwin, F.R.S., President of Mechanical Science Section, at the Annual Meeting of the British Institution.)

WITH the knowledge he had acquired of the relations of the pressure and temperature of steam, its volume at different pressures, and the heat absorbed in producing it, James Watt was able to determine that the quantity of steam used in a model atmospheric engine was enormously greater than that due to the volume described by the piston. There was waste or loss. To discover the loss was to get on the path of finding a remedy. The separate condenser, by diminishing cylinder condensation, annulled a great part of the loss. So great was Watt's insight into the action of the engine that he was able to leave it so perfect that, except in one respect, little remained for succeeding engine builders, except to perfect the machines for its manufacture, to improve its details, and to adapt it to new purposes. Now it very early became clear that there were two directions of advance which ought to secure greater economy. Simple mechanical indications showed that increased expansion ought to insure increased economy. Thermodynamic considerations indicated that higher pressures, involving a greater temperature range of working, ought to secure greater economy. But in attempting to advance in either of these directions, engineers were more or less disappointed. Some of Watt's engines worked with 5 lbs. of coal per indicated horse-power per hour. Many engines with greater pressures and longer expansions have done but little better. The history of steam-engine improvement for a quarter of a century has been an attempt to secure the advantages of high pressures and high ratios of expansion. The difficulty to be overcome has proved to be due to the same cause as the inefficiency of Watt's model engine. The separate condenser diminished, but it did not annul, the action of the cylinder wall. The first experiments which really startled thoughtful steam engineers were those made by Mr. Isherwood, between 1860 and 1865. Mr. Isherwood showed that in engines such as those then in use in the United States Navy, with the large cylinders and low speeds then prevalent, any expansion of the steam beyond three times led, not to an increased economy, but to an increased consumption of steam. Very little later than this M. Hirn undertook, in 1871–75, his classical researches on the action of the steam in an engine of about 150 indicated horse-power. Experiments of greater accuracy or completeness, or of greater insight into the conditions which were important, have never since been made, and Hirn with his assistants, MM. Hallauer and Dwelshauvers-Dery, has determined, once for all, the whole method of a perfect steam-engine trial. M. Hirn was the first to clearly realize that the indicator gives the means of determining the steam present in the cylinder during every period of the cycle of the engine. Consequently, superheating in ordinary cases being out of the question, we have the means of determining the heat present and the heat already converted into work. The heat delivered into the engine is known from boiler measurements, combined with calorimetric tests of the quality of the steam, tests which Hirn was the first to undertake. The balance or heat unaccounted for is, then, a waste or loss due to causes which have to be investigated. Hirn originated a complete method of analysis of an engine test, showing at every stage of the operation the heat accounted for and a balance of heat unaccounted for; and the latter proved to be a very considerable quantity.

Meanwhile theoretical writers, especially Rankine and Clausius, had been perfecting a thermodynamic theory of the steam-engine, based primarily on the remarkable and irrefragable principle of Carnot. The result of Hirn's analysis was to show that these theories, applied to the actual steam-engine, were liable to lead to errors of 50 or 60 per cent., the single false assumption made being that the interaction between the walls of the cylinder and the steam was an action small enough to be negligible.

In England, Mr. Mair Rumley, following Hirn's method, made a series of experiments on actual engines with great care and accuracy and completeness. All these experiments demonstrated the fact of a large initial condensation of steam on the walls of the cylinder, alike in jacketed and unjacketed engines. This condensed steam is reevaporated partially during expansion, but mainly during exhaust, and serves as a mere carrier of heat from boiler to condenser, in conditions not permitting its utilization in producing work.

It became clear from Hirn's experiments, if not from the earlier experiments of Isherwood, that for each engine there is a particular ratio of expansion for which the steam expenditure per horse-power is least. Professor Dery has since deduced from them that the practical condition of securing the greatest efficiency is that the steam at release should be nearly dry. In producing that dryness the jacket has an important influence. In spite of much controversy among practical engineers about the use of the jacket, it does not appear that any trustworthy experiment has yet been adduced in which there was an actual loss of efficiency due to the jacket. In the older type of comparatively slow engines it is a rule that the greater the jacket condensation the greater the economy of steam, even when the jacket condensation approaches 20 per cent. of all the steam used. It appears, however, that as the speed of the engine increases, the influence of the jacket diminishes, so that for any engine there is a limit of speed at which the value of the jacket becomes insignificant.

Among steam-engine experiments directed specially to determine the action of the cylinder walls, those of the late Mr. Willans should be specially mentioned. Mr. Willans' death is to be deplored as a serious loss to the engineering profession. His steam-engine experiments, some of them not yet published, are models of what careful experiments should be. They are graduated experiments designed to indicate the effect of changes in each of the practically variable conditions of working. They showed a much greater variation of steam consumption (from 46 to 18 lbs. per indicated horse-power hour) in different conditions of working than, I think, most practical engineers suspected, and this has been made more significant in later experiments, on engines working with less than full load. The first series showed that in full load trials the compound was superior to the simple engine in practically all the conditions tried, but that the triple was superior to the compound only when certain limits of pressure and speed were passed.

As early as 1878 Professor Cotterill had shown that the action of a cylinder wall was essentially equivalent to that of a very thin metallic plate, following the temperature of the steam; the exceedingly rapid dissipation of heat from the surface during exhaust especially being due to the evaporation of a film of water initially condensed on its surface. In permanent *régime* the heat received in admission must be equal to that lost after cut off. In certain conditions it appeared that a tendency would arise to accumulate water on the cylinder surfaces, with the effect of increasing in certain cases the energy of heat dissipation. Recently Professor Cotterill has been able to carry much further the analysis of the complex action of condensation and re-evaporation in the cylinder, and to discriminate in some degree between the action of the metal and the more ambiguous action of the water film. By discarding the less important actions, he has found it possible to state a semi-empirical formula for cylinder condensation in certain restricted cases which very closely agrees with experiments on a wide variety of engines. It is to be hoped that, with the data now accumulating, a considerable practical advance may be made in the clearing up of this complex subject. There are, no doubt, some people who are in the habit of depreciating quantitative investigations of this kind. They are as wise as if they recommended a manufacturer to carry on

his business without attending to his account books. Further, the attempt to obtain any clear guidance from experiments on steam-engines has proved a hopeless failure without help from the most careful scientific analysis. There is not a fundamental practical question about the thermal action of the steam-engine, neither the action of jackets or of expansion or of multiple cylinders, as to which contradictory results have not been arrived at, by persons attempting to deduce results from the mass of engine tests without any clear scientific knowledge of the conditions which have affected particular results. In complex questions fundamental principles are essential in disentangling the results. Interpreted by what is already known of thermodynamic actions, there are very few trustworthy engine tests which do not fall into a perfectly intelligible order.

There is only one known method, not now much used, by which the cylinder condensation can be directly combated. Thirty years ago superheating the steam was adopted with very considerable increase of economy. It is likely that it was thought by the inventor of superheating that an advantage would be gained by increasing the temperature range. If so, his theory was probably a mistaken one. For the cooling action of the cylinder is so great that the steam is reduced to saturation temperature before it has time to do work; but the economy due to superheating was unquestionable, and was very remarkable considering how small a quantity of heat is involved in superheating. The heat appears to diminish the cylinder wall action so much as almost to render a jacket unnecessary. The plan of superheating was abandoned from purely practical objections, the superheaters then constructed being dangerous. Recently superheating has been tried again at Mulhouse by M. Meunier, and his experiments are interesting because they are at higher pressures than in the older trials and with a compound engine. It appears that even when the superheater was heated by a separate fire there was an economy of steam of 25 to 30 per cent. and an economy of fuel of 20 to 25 per cent., and four boilers with superheating were as efficient as five without it.

It may be pointed out as a point of some practical importance that if a trustworthy method of superheating could be found, the advantage of the triple over the compound engine would be much diminished. For marine purposes the triple engine is perfectly adapted. But for other purposes it is more costly than the compound engine, and it is less easily arranged to work efficiently with a varying load.

There does not seem much prospect of exceeding the efficiency attained already in the best engines, though but few engines are really as efficient as they might be, and there are still plenty of engines so designed that they are exceedingly uneconomical. The very best engines use only from 12 to 13 lbs. of steam per indicated horse-power hour, having an absolute efficiency reckoned on the indicated power of 16 per cent., or reckoned on the effective power, 13 per cent. The efficiency, including the loss in the boiler, is only about 9 per cent. But there are internal furnace engines of the gas-engine or oil-engine type in which the thermal efficiency is double this.

THE LAKE CHANNEL.

The Cleveland *Marine Record* states that the contracts for the completion of the 20-ft. channel from Buffalo to Chicago and Duluth will be awarded in eight distinct sections, and work must be begun by May 15, 1893, and completed within three seasons of 200 working days each, between May 15 and November 30. Congress has limited the cost of the channel to $3,340,000, of which $375,000 are now available.

The first section comprises the improvement of two shoals in St. Mary's River above the canal. The upper shoal lies northwesterly and the lower shoal northeasterly from the old Round Island lighthouse. The work to be done consists in excavating a channel within the side and end lines, the estimated excavation being 90,000 cubic yards.

The second section comprises the improvement of Little Mud Lake, between the lower end of Sugar Island and the lower end of the Dark Hole, St. Mary's River, the estimated excavation being 380,000 cubic yards.

The third section comprises the improvement of a reef abreast of Sarton Encampment Island, St. Mary's River, the estimated excavation being 90,366 cubic yards.

The fourth section comprises the improvement of a shoal about 1½ miles below Sarton's Encampment in Mud Lake, St. Mary's River, the estimated excavation being 67,100 cubic yards.

The fifth section comprises the improvement of a number of small shoals at the foot of Lake Huron, the estimated excavation being 256,000 cubic yards.

The sixth section comprises the improvement of the St. Clair Flats, the estimated excavation being 950,000 cubic yards.

The seventh section comprises the improvement of Grosse Point Flats, the estimated excavation for the width of 300 ft. being 120,000 cubic yards.

The eighth section comprises the improvement of the bar at the mouth of the Detroit River, the estimated excavation for the width of 300 ft. being 11,000 cubic yards.

IRRIGATION IN INDIA.

(Translated from *Mémoire* by Chief Engineer Barois, in *Les Annales des Ponts et Chaussées*.)

(*Continued from page 569, Volume LXVI.*)

RESERVOIRS.

In many districts of India, and especially in the central and southern provinces, the reservoirs are the chief reliance for irrigation. This is the case not only in the dry season, when the flow of the streams becomes very small, but also in the rainy season, because the rains last but a short time and the water which falls flows away rapidly, although there are occasionally violent storms when the rainfall amounts to as much as 10 in. or 12 in. in 24 hours.

These regions have, from almost prehistoric times, been dotted with reservoirs of all sizes, which are fed by the rain falling on the neighboring slopes, by the smaller streams and by the rivers.

In the government of Madras there are between 50,000 and 60,000 of these reservoirs. The dykes or dams inclosing them have a total length of over 30,000 miles, and they have altogether some 300,000 works of masonry, small and large.

These reservoirs vary very much in size; many of them are of small extent, as may be seen by taking some districts of the province as examples.

In the Kistna District there are 657 reservoirs, of which 5 only supply water for irrigating over 1,000 acres each; 15 supply from 500 to 1,000 acres, while 384, or more than half, supply less than 50 acres each.

The North Arcot District has 3,297 reservoirs, of which 981 supply less than 10 acres each; 506 from 10 to 20 acres; 777 from 20 to 50 acres each, while 17 supply from 500 to 1,000 acres, and 4 only over 1,000 acres each.

In the South Arcot District, out of 3,495 reservoirs 1,970 —much more than half—supply less than 50 acres each, while only 37 are large enough for the wants of over 500 acres.

The Madura District has no less than 13,291 reservoirs; but of these 48 only supply more than 1,000 acres each, while 12,580 furnish water for less than 200 acres, 1,116 supplying from 20 to 30 acres each; 2,073 from 10 to 20 acres each, and 5,518 less than 10 acres each.

The banks of the old reservoirs are built entirely of earth. Many of them are formed by dams closing narrow gorges, above which are found natural basins of greater or less extent. Thus the reservoir of Cammun, in the Guntoor District, which has an area of 10,000 acres, is formed by a dam 100 ft. high closing a ravine about 300 ft. across. The dam is of earth with slopes of about 1 to 2; the upper slope is covered with stone. This reservoir holds water enough to irrigate the district it serves for two seasons.

In the Mysore District the Nuggur Reservoir has a perimeter of 49 miles, but the dam is only 1,000 ft. long; this dam has a maximum height of 84 ft. and is 580 ft. through at the base. In the same district, on a branch of the Lokain River, there is another large reservoir with a dam closing a

defile only 225 ft. in width; the height of this dam is 125 ft., and it is about 400 ft. through at the base.

In many cases reservoirs are established on undulating plains, where the slope of the ground is from 1.5 to 2 ft. in 1,000. They are then formed by a dam crossing the plain at right angles to the general slope, and by two lateral dams or dykes running up the slope. Reservoirs of this class require a great length of dyke. They are placed as much as possible in situations where they do not depend entirely on the rainfall, and are most frequently supplied by a natural watercourse or a feeder canal from a river.

Some of these reservoirs, supplied by rivers or natural streams, are of great extent. The Chebranbankam Reservoir, near Madras, covers about 6,200 acres; it has a dam 3.4 miles long, which holds back a maximum of 20 ft. of water. The overflows have a total length of 650 ft.; the reservoir will hold nearly 2,960,000,000 cub. ft. of water, and will irrigate 10,000 acres of rice. The Veeranum Reservoir, in the South Arcot District, is fed by a canal from the Coleroon River; its dams are 12½ miles long and 20 ft. in maximum height. Its surface is 20,000 acres and its capacity is about 2,800,000,000 cub. ft. Red Hill Lake, which furnishes water to the city of Madras, is supplied by a special canal. It has a dam 3¾ miles long and 20 ft. high, a surface of 6,200 acres and a capacity of 27,000,000,000 cub. ft.; the overflows are 300 ft. in length.

In the Mysore District, where every drop of water is saved, we find a series of reservoirs arranged in *echelon* one above the other in the same valley; the reservoir below is placed at the point where irrigation from the next one above ceases.

The English engineers have not established new reservoirs in the presidency of Madras, but have only improved and developed the works which they found already in existence. They have taken care that the dams should be kept up to their normal height and profile, the overflows properly proportioned and solidly built, the feeder canals provided with suitable headworks; in short, that the system should work with the regularity and safety necessary to a successful system of irrigation.

The earth dams are generally built of material taken from pits near their sites. The earth is puddled or worked down simply by the feet of the men employed in their construction; but as the work generally requires at least two seasons, the rains of the monsoon assist. The inclination or slope varies from 2 to 3 of base to 1 of height; on the outer slope 1½ or 2 to 1 is generally sufficient. It is generally considered necessary to make the dam at high-water level as wide as the maximum depth of the water held back. It is recommended also, as a measure of security, that the dam should extend from 8 to 10 ft. above the highest water level.

The upper slopes of earth dams are generally protected by a covering of stone, clay or turf. The stone protection varies from 2 to 4 ft. in thickness; in some large reservoirs the stones are from 5 to 6 cub. ft., carefully placed with headers, or arranged in steps; in others the facing is simply riprap placed without special care.

The natives often consider it a sufficient protection to plant trees on the dykes.

In the small reservoirs they often use as facing fascines of rushes placed horizontally along the slope. After a short time these rushes take root and the slopes are soon covered with a thick vegetation. This system is so efficacious that along the rivers in the Tanjore Delta, where stone is not to be found, all the dykes are protected in this way.

Each reservoir is provided with one or more overflows. When these are not founded on rock or solid bottom, they are protected by stone facing having at least three or four times the width of the opening; this is at least equal to twice the height of the fall measured from the surface of the water to that of the base. The thickness of the stone depends on the fall; with a fall of 10 ft. and a depth of 3 ft. passing over the crest of the outflow the stone is at least 4 ft. thick.

The aqueducts taking water from the reservoirs are usually of masonry. They are often so arranged that they can be used to supply several canals at different levels.

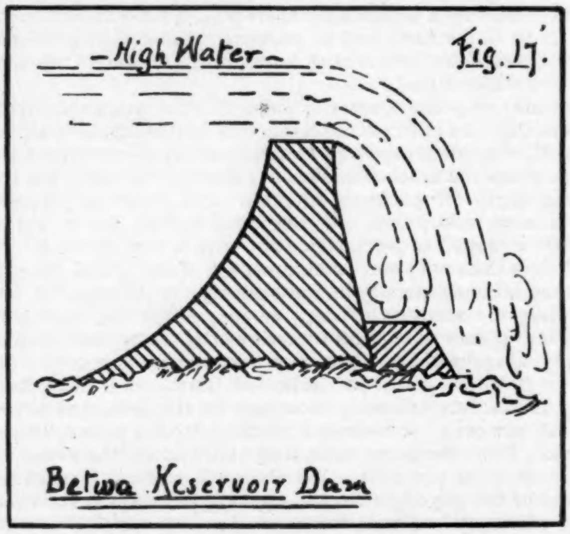
In Upper India there is less need of reservoirs, because the rivers there usually supply water throughout the year. There are, however, several in places where all the rain of the monsoon falls in a short time and where the surface is undulating in such a way that the water falling during heavy rains will flow off rapidly, producing only a very transient effect on the land. Reservoirs so placed which have had a very good result are those of Ajmere, of Cairwara and of Kalra. The last named holds about 530,000,000 cub. ft. of water.

In Central India there are many small dams on the less important rivers, the object of which is to maintain a certain reserve of water which will, by infiltration, feed the wells from which water is drawn for irrigation. The utility of these works is, however, not admitted by many experts. A dam of this class is that of Nya-Nagar, which is a masonry wall founded on a rocky bed. It is 312 ft. long, 10 ft. thick at the base and 7 ft. at the crown, and is 13 ft. high. It holds back the water in the stream for about 4,000 ft.

In the presidency of Bombay the English engineers have begun the construction of several fine irrigation reservoirs which deserve some special description.

1. *The Mutha Reservoir.*—This is on the Mutha, a tributary of the Kistna, about 10 miles from Poona. It is fed by the periodical rains which fall on the slopes of the Western Ghats and is intended to irrigate a very dry district on the great plain of the Deccan; it also furnishes water for the city of Poona and a number of villages.

This reservoir is formed by a wall of masonry founded on rock and having a length of 3,680 ft., not including an overflow 1,450 ft. long. The crest of the dam is 99 ft. above the river bed, and the overflow is 11 ft. below the crest, making the maximum depth of water in the reservoir 88 ft. The superficial area of the reservoir is 3,700 acres, and its total capacity is 5,152,500,000 cub. ft. of water.



2. *The Ekruk Reservoir.*—This work is in the same region as the Mutha Reservoir; it is on the Adhila River, 5 miles northeast of Sholapur. The dam is 7,200 ft. long; it is formed at the two ends by two masonry walls respectively 1,300 ft. and 1,400 ft. long, the central portion, 4,500 ft. long, being an earth dam, the maximum height of which above the river bed is 75 ft. This dam has a slope on the up-stream side of 1 in height to 3 of base, and of 1 to 2 on the lower side. On the up-stream side the slope is protected by riprap about 2 ft. thick. An overflow is made in the rock on each side, at each end of the dam, the total width of the openings being 370 ft.

The capacity of this reservoir is about 3,320,000,000 cub. ft. of water. Its superficial area is 4,000 acres. The watershed from which it is supplied covers about 90,000 acres. It supplies water to irrigate 21,500 acres of land through three canals located on different levels.

3. *The Betwa Reservoir.*—This reservoir is formed by a dam built across the valley of the River Betwa; the flow of the river in flood times rises to a maximum delivery of 700,000 cub. ft. per second.

This fine dam is founded on the rocky bed of the river,

and is built entirely of granite blocks with cement mortar. At the highest point the crest is 50 ft. above the river bed. The crest is 15 ft. in width. The front of the wall is vertical for a short distance and then has a batter of 24 in 100. The up-stream side has a curved profile. For a height of 50 ft. the wall is 61 ft. thick at the base.

A section of this dam at the highest point is shown in fig. 17. In front of the dam there is a counterfort of masonry, as shown in the section, placed there to protect the foundation against the wearing effect of the immense mass of water which falls over the dam in time of flood.

During the dry season water is taken from the reservoir by a canal; the head of this canal is provided with gates to regulate the flow. In the season of floods the water flows over the crest of the dam in a stream which is sometimes 18 ft. or 20 ft. deep.

This dam is one of the best of the new works constructed by the English engineers in India. It is at a point where an earth dam could not possibly stand, and where some means of retaining water for the dry season was necessary.

(TO BE CONTINUED.)

AREAL WORK OF THE GEOLOGICAL SURVEY.

(Condensed from paper by W. J. McGee, read before the American Institute of Mining Engineers.)

WHEN the United States Geological Survey began its work some 20 years ago, it was apparent that the first thing needed was the preparation of a topographical map. What was required was not a detailed map, but one giving the main landmarks and contour lines, and this has been carried out. At first scales of four miles, two miles and one mile to an inch were proposed for different sections, but finally a uniform scale of one mile to the inch was adopted, as the smallest meeting the requirements of geologists.

Up to the present time the area surveyed has been 537,000 square miles, distributed over 42 States and territories. The District of Columbia and four States—Connecticut, Massachusetts, New Jersey and Rhode Island *—have been completed. The maps are printed in sheets about 15 × 18 in., the side of each representing 15 minutes of latitude. The sheets are engraved on copper and printed from stone transfers, and it may be added that they are beautiful specimens of cartographic work. Each sheet is in three colors, the hydrography being given in blue, the altitudes between contour lines in brown and the topography in black. Surveys are completed for 694 sheets, of which 615 have been printed.

The law makes no provision for the sale of these maps, but it is expected that some arrangement will be authorized hereafter by which those who desire them can procure them at a fixed price.

Unfortunately the geologists of different countries have never agreed upon any uniform system of representing geological structure in maps, so that each country has adopted some plan of its own. The Geological Survey has adopted a system which has met with general approval thus far. This provides for the separation of rock formation into four classes, as follows:

1. Fossiliferous or Fragmental.
2. Volcanic.
3. Granitoidal and Schistoidal.
4. Superficial.

These classes of rocks are represented by ground colors and pattern overprints in such a way that the entire range of available colors may be used for each. The fragmental rocks are represented by the primary colors in orderly arrangement, each color indicating an age-group (Carboniferous, Silurian, etc.). These colors, used as uniform ground tints and overprints in line patterns, represent the distinct formations of which the group is made up. The volcanic rocks are represented by angular figures either on a white ground or over a ground tint representing an age-group. The crystalline rocks are similarly represented by hachures disposed either irregularly or in such a manner as to indicate structure. The superficial deposits are represented by round figures in such a manner that they may be mapped in their normal relation, overlying the older rocks, on the sheets showing the underlying formations.

The general system provides for the representation of the geology on the topographical maps. The atlas sheets are colored in manuscript by the geologists in the field and the geological symbols are afterward engraved on zinc. In order to make these sheets available for all uses, provision has been made for printing each sheet in portfolio form, supplemented by as many different impressions of the same map as may be required. Thus the portfolio will usually include a topographic sheet without geological symbols; a geological sheet showing only the age-groups and formations; a structure sheet in which sections drawn to scale are printed on a sheet showing the groups and formation boundaries; sometimes a sheet of columnar sections showing the structure in greater detail; in some cases a sheet showing the superficial deposits only; and, when the occasion requires, a sheet of mineral resources, showing the location of mines, quarries, coke ovens, smelters and furnaces, as well as mineral areas.

These geological surveys consume much time. Moreover, a variety of circumstances have combined to delay the completion of the surveys except in special districts, such as the Lake Superior iron region, the quicksilver and gold regions of California, the phosphate belt of Florida, the Eureka and Virginia City districts in Nevada, and some mining areas in Colorado.

Final geological surveys of greater or less extent have been executed in 32 States and territories. These surveys cover an area of 117,000 square miles, and are in part represented on 100 regular atlas sheets and a large number of special maps.

The cost of the topographical surveys has varied with the scale and other conditions from less than $1 to over $5 per square mile. The average cost of the survey, including drawing, has been $3 per square mile on the one-mile-to-the-inch scale, and the total cost since the first has been about $4 per square mile. The cost of the geological survey has varied between much wider limits. In fairly representative districts it has averaged $5 to $6 per square mile. The cost from the beginning has averaged $8 per square mile, but this includes preliminary expenditure on instruments, books, laboratories and similar matters.

* In Massachusetts and New Jersey the work has been done in co-operation with the State geological surveys.

CANALS IN INDIA.

(Condensed from the *Indian Engineer*.)

WE seem, if exchange goes on falling, likely for this cause alone to be soon entering upon a great canal-making era in Indian public works. For canals are the only class of large works (except planting State forests) which require but little imported plant. They can be carried out by excavation, stone-cutting and carpentry, as far as the bulk of the expenditure is concerned.

The disfavor attached to canals hitherto has been also in a great degree due to the attempts at combining the irrigation which involves a rapid current, with navigation requiring nearly still water. Then it was claimed for canals that they were better suited to India than trunk railroads, which few will be ready to admit.

Now that 16,000 miles of trunk railroad lines have been opened in this country, and silver is cheap in the West while it retains its former purchasing power in the East, the circumstances are totally changed; and canals are wanted, not in order to take the place of railroads, but to relieve them in some measure of their superabundant traffic.

There is, however, not the same field for canal as for railroad extension in India. The summit levels at which water to keep the canals full can be obtained in the interior are limited, and far apart. Then very little use can be made of the rivers themselves in navigation, on account of the strong current and considerable fall of their bed in most cases. They also run almost dry between rainy seasons.

This scarcity of water during the summer months necessitates the construction of one or more huge inland lakes, if canal communication is to be uninterrupted throughout the

year. There are favorable sites for lakes of this kind, particularly in the Mysore Ghat region; and examples are not wanting, in those long ago formed under native dynasties, at Jhansi, Hyderabad, Ajmere and other places.

Having fixed upon a choice out of the small number of summit levels available, laying down the canal routes on a map becomes an almost mechanical operation. Notwithstanding the many seeming difficulties, it would be quite practicable to lead a navigable canal—some 40 ft. wide and 5 ft. to 10 ft. deep—all the way from Allahabad, through the Rewah territory, and the heart of the Deccan, down to the Coromandel Coast; and then by a canal route already partially opened, right round Cape Comorin to the Bombay frontier in North Canara.

The highest summit level of such a canal, it is true, would be 1,500 ft. above the sea, and yet what at the first blush seems a troublesome obstacle may be shown, owing to the command of water-power it gives, a striking advantage.

By an adaptation of the trolley system used on electric railroads, the boats could be propelled by power furnished from turbines and dynamos at the locks. In many places locks could be replaced by inclines operated by water-power.

In designing canal systems for India there are one or two considerations to be kept in view. The evaporation is so great in a tropical climate that it is important to have depth rather than width. So that though 5 ft. of water would accommodate a fair amount of traffic, and it may be a long time before steam vessels are employed, the depth to be aimed at should not be less than 10 ft., either at once or by degrees.

Again cheap freight requires capacious boats, and they should therefore be of the largest size the locks will admit (or multiples of that size so as to go through in a batch).

There are no examples in India of either rivers or canals which have been able to compete with railroads.

We have said that irrigation ought not to be combined with navigation in an Indian canal; but some exception may be made. A current of a mile—and perhaps even up to two miles an hour—does not sensibly affect the speed of animal traction on a canal, so that a certain amount of water could be sold for irrigation.

As a precaution against famine in the Deccan, where rainfall is at intervals scanty and always light, the presence of a deep river-supplied navigable canal must prove a vast benefit. It would save the crops for miles on either side, and fill village wells.

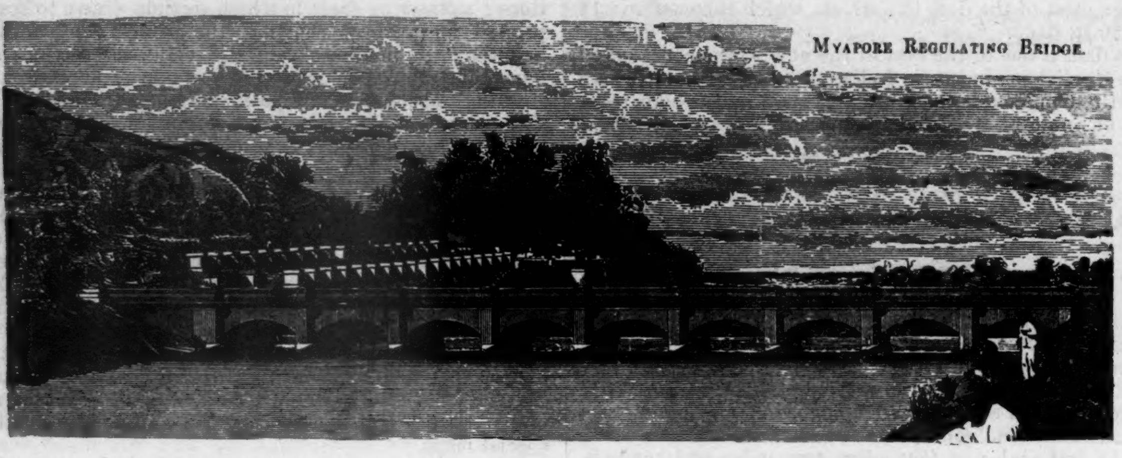
Little has to be said about a system of canals for navigation in the plains watered by the Ganges and Indus. It is obvious that as they prove successful on a moderate scale further south, immense canals will be required following the course of, as well as branching off from, these rivers. Nor will it take long for the railroad managements to see that much of their bulky freight should go by canal rather than in expensively hauled trains; and then to bid to have the working of canal traffic, with the result of cheaper average freight rates for India all round.

WORKS ON THE GANGES CANAL.

(From *Indian Engineering.*)

The works at Myapore and Dhunowri are the most important of the drainage works on the Ganges Canal in the tract of country above Roorkee. Although they may be classed under the head of inlets as well as escapes for regulating the supply, they fall more appropriately under the denomination of dams and drainage works.

In fig. 1 we give a plan of the works which were originally constructed in connection with the departure of the Ganges Canal supply from the Ganges River and its branch at Myapore.



Myapore Regulating Bridge.

The Myapore Regulating Bridge—shown in the first of the large engravings—at the head of the Ganges Canal is the main connecting link between the towns of Hurdwar and Kunkhul, and the high road from Roorkee to Dehra passes over it. It was intended to serve the dual purpose of a public thoroughfare as well as the means for determining the amount of water passing into the canal, having a roadway of 39½ ft. in width.

The original Myapore headworks consisted of a brick regulator, with 10 bays of 20 ft. each, 16 ft. high, two wooden gates in each bay, inside the mouth of the canal, shown in our illustration. The river was governed by means of a weir 517 ft. in length. Its central escape, resting upon an 8-ft. floor of brick, over bowlder masonry 44 ft. wide, had 15 openings between brick piers, 3 ft. high and 10 ft. apart, fitted with drop gates and further raised by means of planks. The weir rose from the center to flank walls on each side 24 ft. in height, extending 800 ft. down stream, a lock-stand above the canal mouth running from it at an acute angle.

Fig. 1.

General Plan
Myapore Head Works.

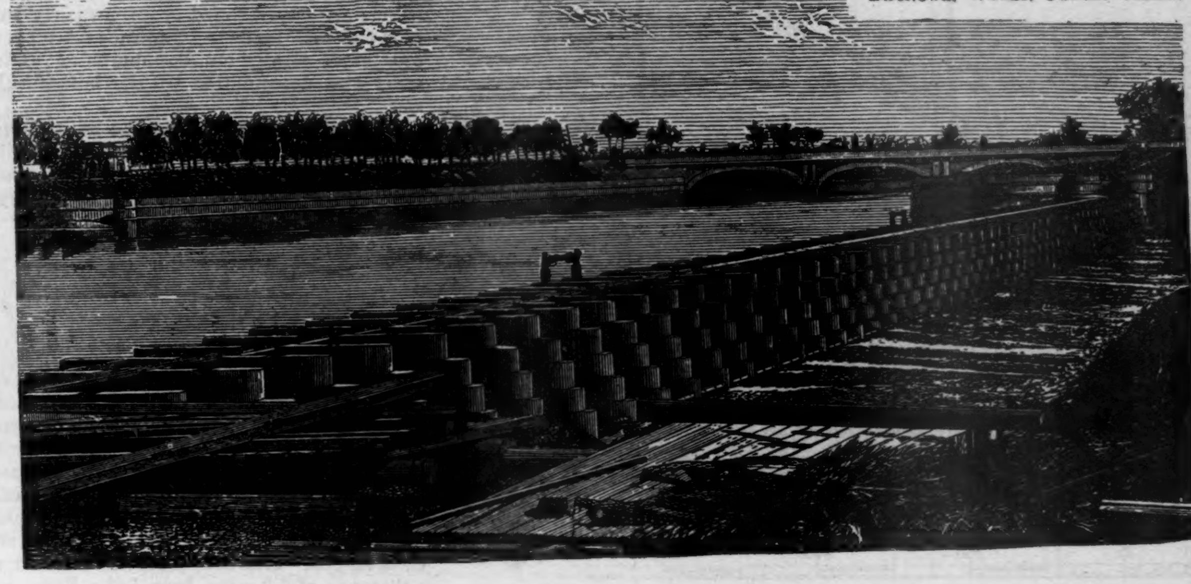
The second large engraving is a general view of the

Dhunowri works, which consist of a dam and inlet thrown across the Rutmoo torrent; a regulating bridge, and a bridge of cross communication in connection with the canal channel; and revetments with a variety of drainage works appended to them. These various details are shown in the site plan, fig. 2, which will lead to an easy understanding of the subject.

suit local requirements. These works are said to have cost nearly six lakhs of rupees.

It should be mentioned that the dam which appears in the illustration of the Dhunowri works shows a footway, which has now been superseded by a bridge. The box-work, filled with stones and held in position by piling, on the down-stream side of the dam has furnished the model

DHUNOWRI WORKS, GANGES CANAL.



The Dhunowri works are situated about 13 miles below the head of the Ganges Canal, at its intersection with the Rutmoo River, which it meets on its own level, and the sills of the different works are therefore on the same level.

Our view shows the dam as originally constructed. It consists of 47 sluices of 10 ft. in width separated by piers $3\frac{1}{2}$ ft. thick. These vents are flanked on each side by five sluices of the same width but having their sills raised 6 ft.,

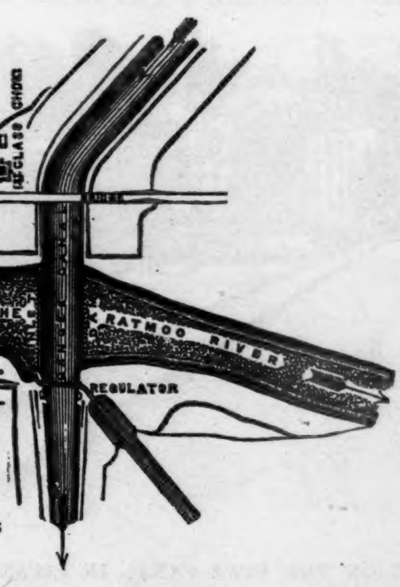


Fig. 2.

SITE PLAN

DHUNOWRI WORKS

the piers being of the same thickness as those of the center sluices. On the extreme flanks are platforms raised to a height of 10 ft. above the canal bed and corresponding in height with the rest of the piers. These elevated platforms, which are 17 ft. in length, are connected with the revetment by inclined planes. The revetment walls both on the right and left are of the same design, and, like the inlet, call for no remark. The bridge over the canal consists of three bays of 55 ft. each, 20 ft. in height from soffit of arch to floor of canal. The regulating bridge is almost identical with the Myapore Regulator, with minor modifications to

for the crib-work weirs lately constructed in connection with the Irrigation Works of Upper Burma.

TESTS OF METALLIC RAILROAD TIES.

An interesting note on a test of track laid on metallic ties has been made public by Herr Ast, Chief Engineer of the Kaiser Ferdinand Northern Railroad in Austria. In August, 1883, a trial section of 2 km. on the Vienna-Cracow line of this road was laid with Bessemer steel ties of the Heindl pattern, the rails—of the Vignoles or Stevens type, weighing 71 lbs. to the yard—being secured to the ties by clips and bolts. The corresponding section of the opposite track was at the same time laid with new oak ties treated by the chlorate of zinc process. The rails and rail-joints used were of the same pattern on both sections, and the traffic over each would, of course, be very nearly the same. The section is on a grade of 0.5 per cent.; part on a tangent and part on a curve of 4,350 ft. radius.

The arrangement of the ties on the two sections is very nearly alike, eight metal or eight wooden ties being used to a 22-ft. rail. Both kinds of ties are the same length, 8 ft.

From the time these sections were laid, in August, 1883, up to December 31, 1891, the number of trains passing over the section with metal ties was: Express passenger, 26,303; local passenger, 2,526; freight, 51,614; total, 80,443 trains. The average total weight of trains was 528 tons, and the total weight passing over the section was 42,480,000 tons.

It should be noted that one kilometer of the test section was ballasted with gravel and the other with broken stone, the stone being a hard limestone.

The results of this trial have proved altogether favorable to the metal ties. The rails have been kept in good alignment and level, and during the whole period there was no necessity for correcting the gauge. A careful account kept of all labor and material shows that the section on metal ties cost 14 per cent. less for maintenance than the corresponding section on wooden ties. The expense of the latter increased toward the end of the eight years, because some of the ties had to be replaced; and this expense, it is expected, will continue to increase for several years, as more new ties are needed.

After a service of nine years the metallic ties are, to all

appearances, perfect, and the engineer in charge cannot fix any time at which they will probably require renewal. The attachments of the rail are also in good condition, and the only material required for renewals has been a few bolts and nuts; even these were called for not on account of actual wear, but because of the misuse of tools by trackmen. The rails laid on these ties are in excellent condition, and show only the normal wear which might be expected from the loads they have carried. No rails were broken.

It is noted that the average annual expenses of maintenance of the kilometer ballasted with gravel were 4 per cent. less than those of the kilometer with broken stone. Other considerations also showed that with metallic ties the gravel ballast is much to be preferred.

There has been no complaint of lateral movement of the track, although many trains pass over it daily, including five fast express trains which sometimes attain a speed of 45 to 50 miles an hour.

The results obtained have been so satisfactory that the management of the road has decided to use these metallic ties for all renewals, and has already 364 km. of track laid upon them.

Results quite as good have been obtained with steel ties of the Heindl type on the Bavarian State Railroads, in a test extending over several years.

Herr Ast refers to the unfavorable results obtained on the Belgian State railroads with metallic ties of the Post and Braet types. He considers that the difference in results was not due to the form or material of the ties, for the material was the same, and the form does not greatly differ; nor to the strains thrown upon them, which do not pass the limit of elasticity, and which were really less on the Belgian lines than on the Kaiser Ferdinand Railroad. The difference in results he attributes entirely to the method of fastening the rails to the ties, which he considers imperfect in the Post and Braet systems, while in the Heindl tie the fastenings are so arranged as to properly support the rail, hold it in place and prevent too great strains on the bolts or undue wear and deformation of the holes in the ties.

These results seem to be the most favorable yet obtained in Europe with metallic ties; and the test seems to have been made with entire fairness and freedom from prejudice.

Fig. 1.

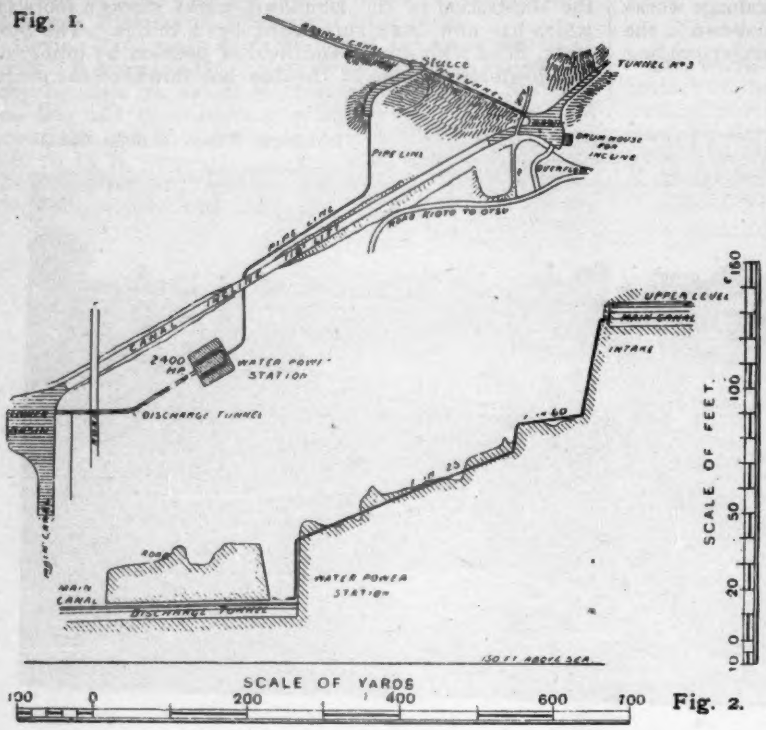
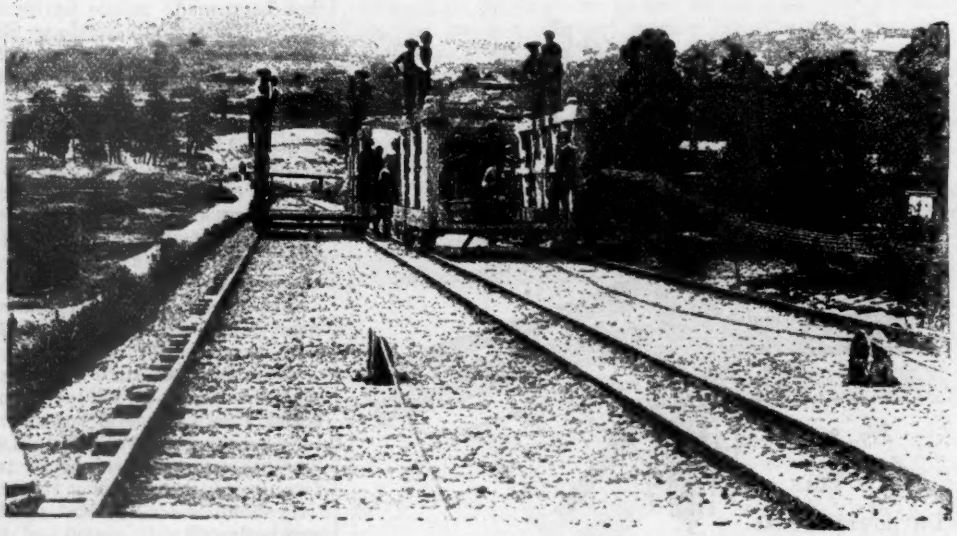


Fig. 2.

INCLINED PLANE ON THE BIWA CANAL IN JAPAN.

A JAPANESE CANAL.

SOME reference has heretofore been made to a canal recently completed in Japan, which extends from Lake Biwa to the city of Kioto. This canal is 6.9 miles long, and its construction has required some difficult work. It passes through three tunnels which are respectively 8,040 ft., 411 ft. and 2,802 ft. in length. Just below the third tunnel, at a distance of 5.3 miles from Lake Biwa, the canal is divided into two. One branch—the high-level—is used for irrigation purposes, while the other, which is designed for navigation, descends 118 ft. in a distance of 1,800 ft. to the level of the city, a slope of about 1 in 15. The boat traffic at this point is worked by an inclined plane-way, the boats being put into a wheeled cradle, which is hauled up and let down by means of a wire rope. In the illustrations—which are from *Industries*—fig. 1 is a plan and fig. 2 a profile of the incline. Fig. 3 is a view taken on the slope, showing the cradles in which boats are carried.



BOAT INCLINE ON THE BIWA CANAL IN JAPAN.

The cables of the inclined plane are operated by electric energy furnished by a Sprague motor driven by a Pelton water-wheel. The fall of the canal also affords a very valuable water-power, a part of which has already been utilized

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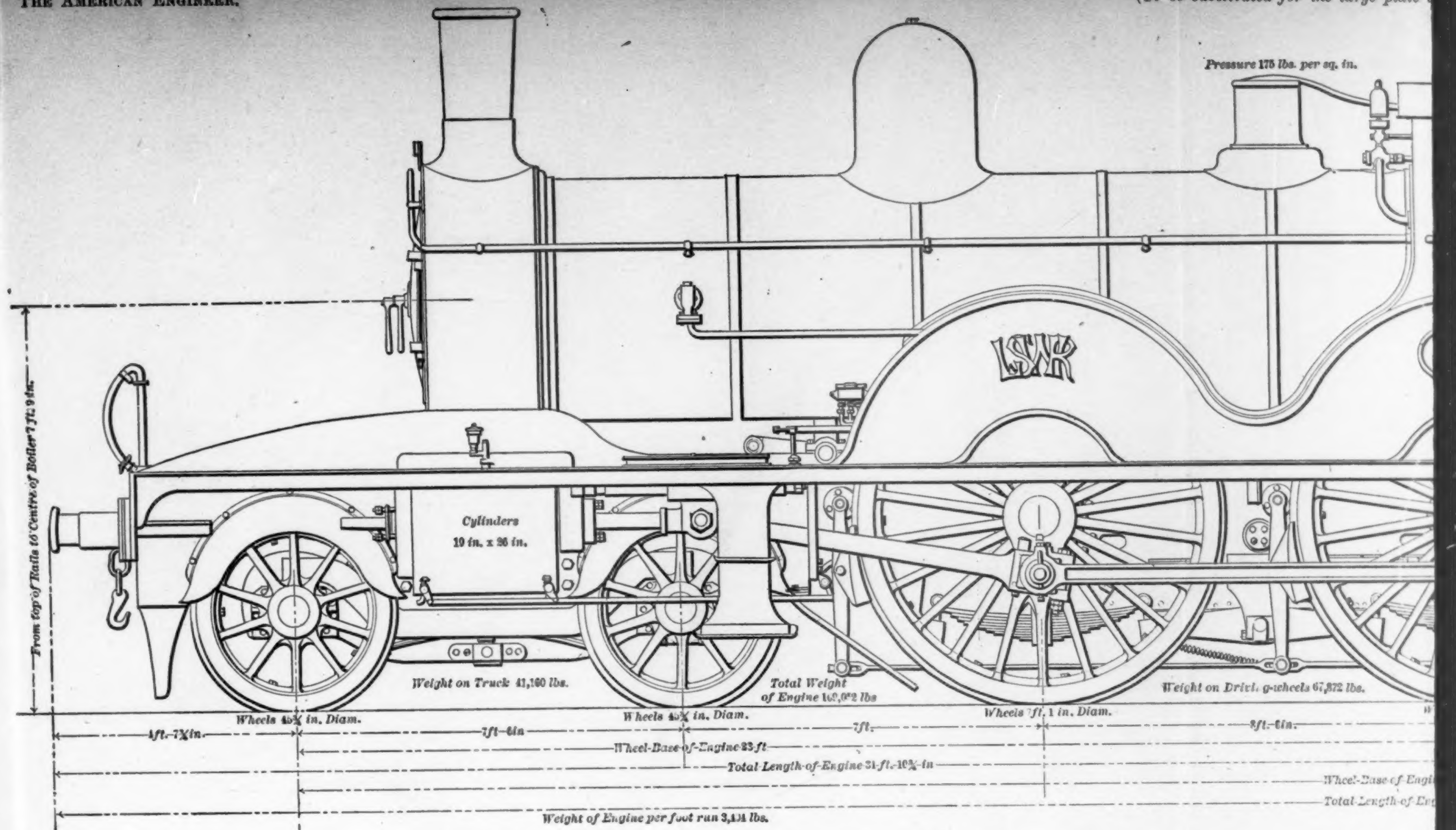

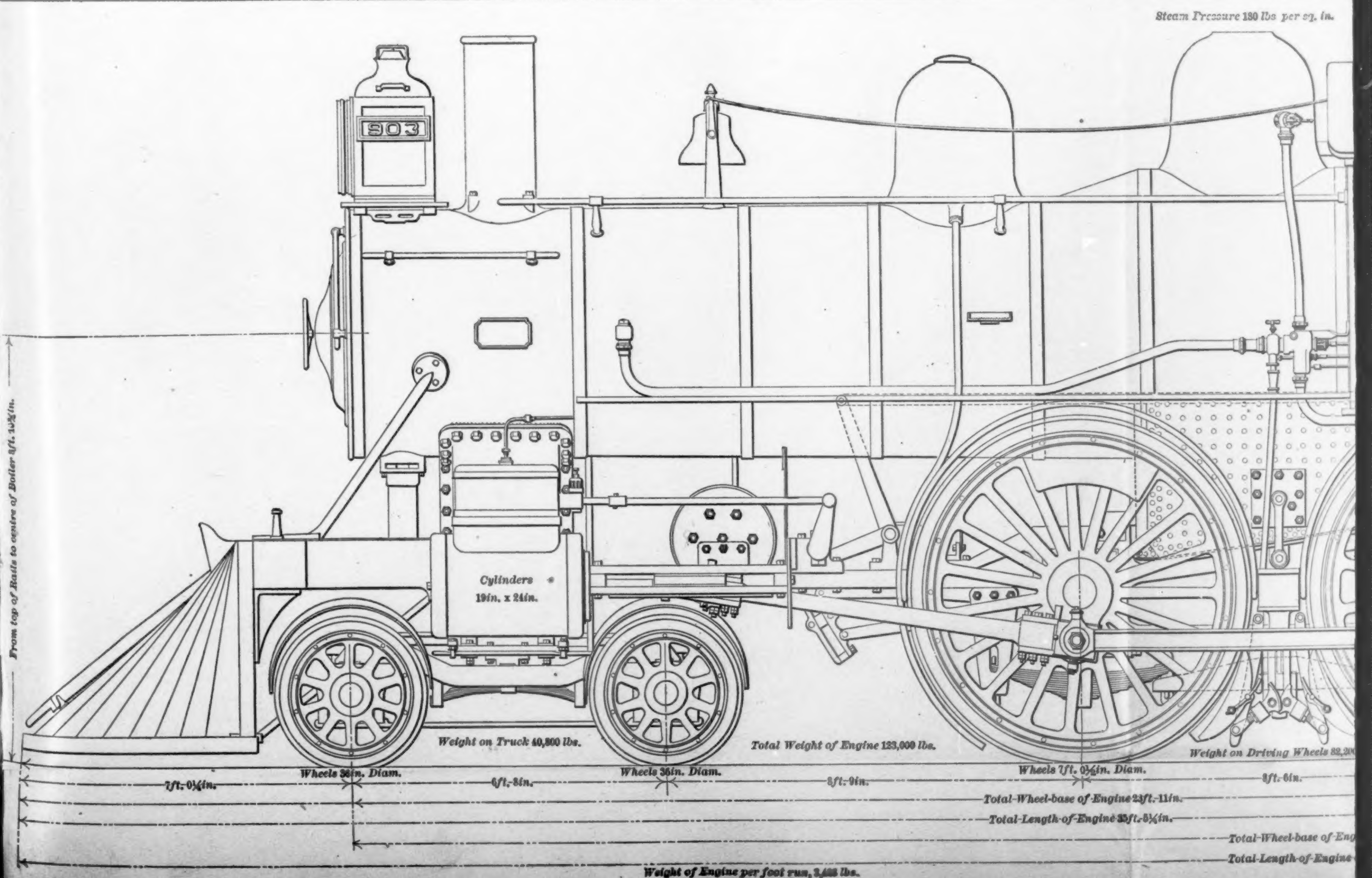

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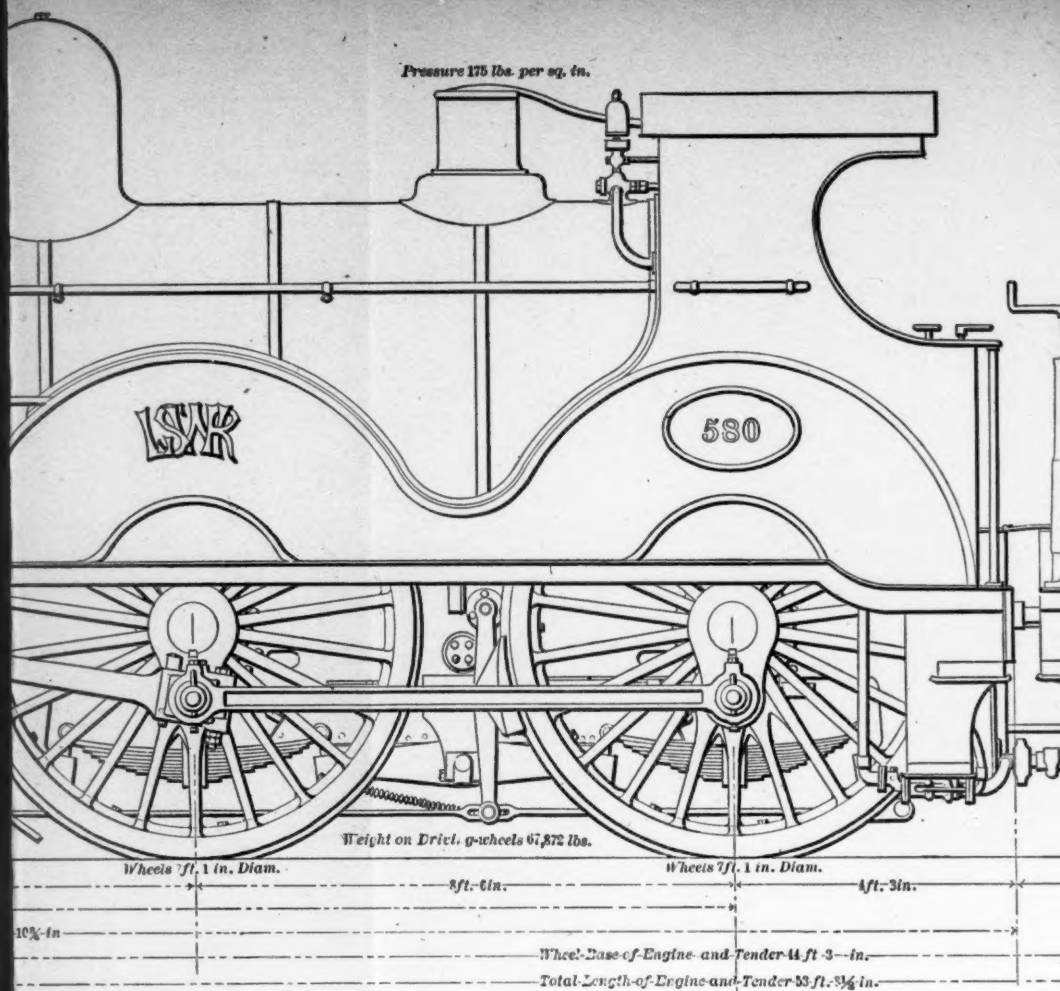

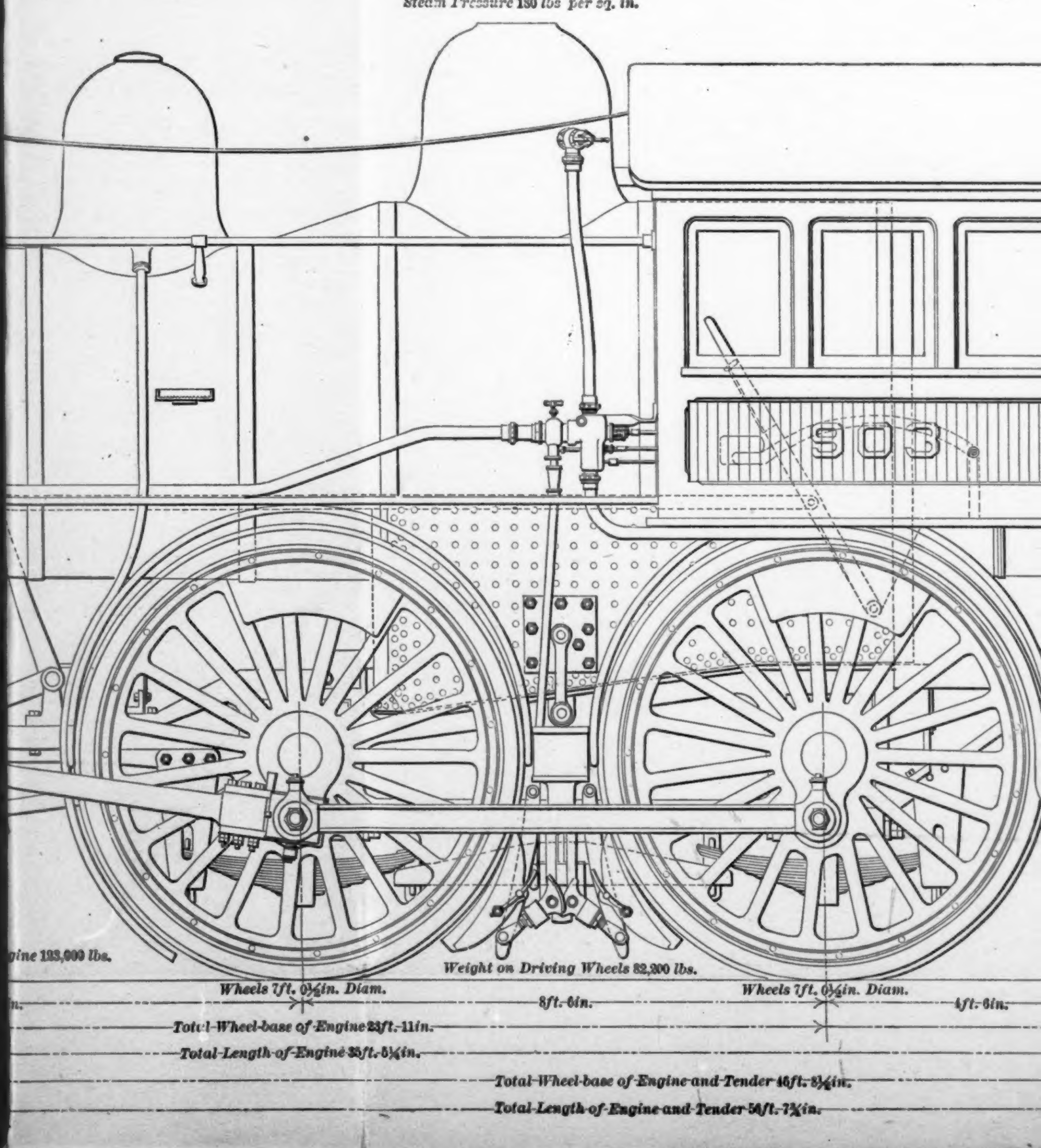

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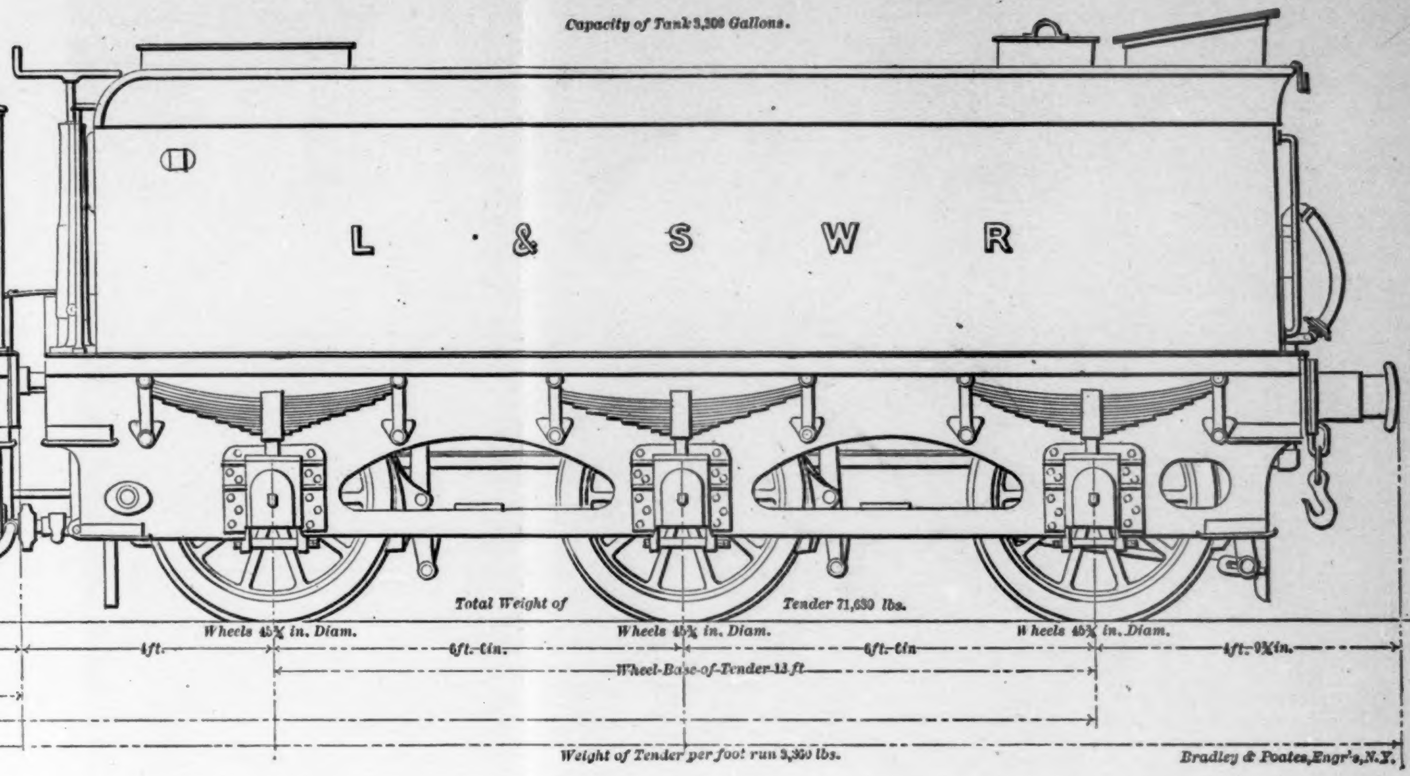

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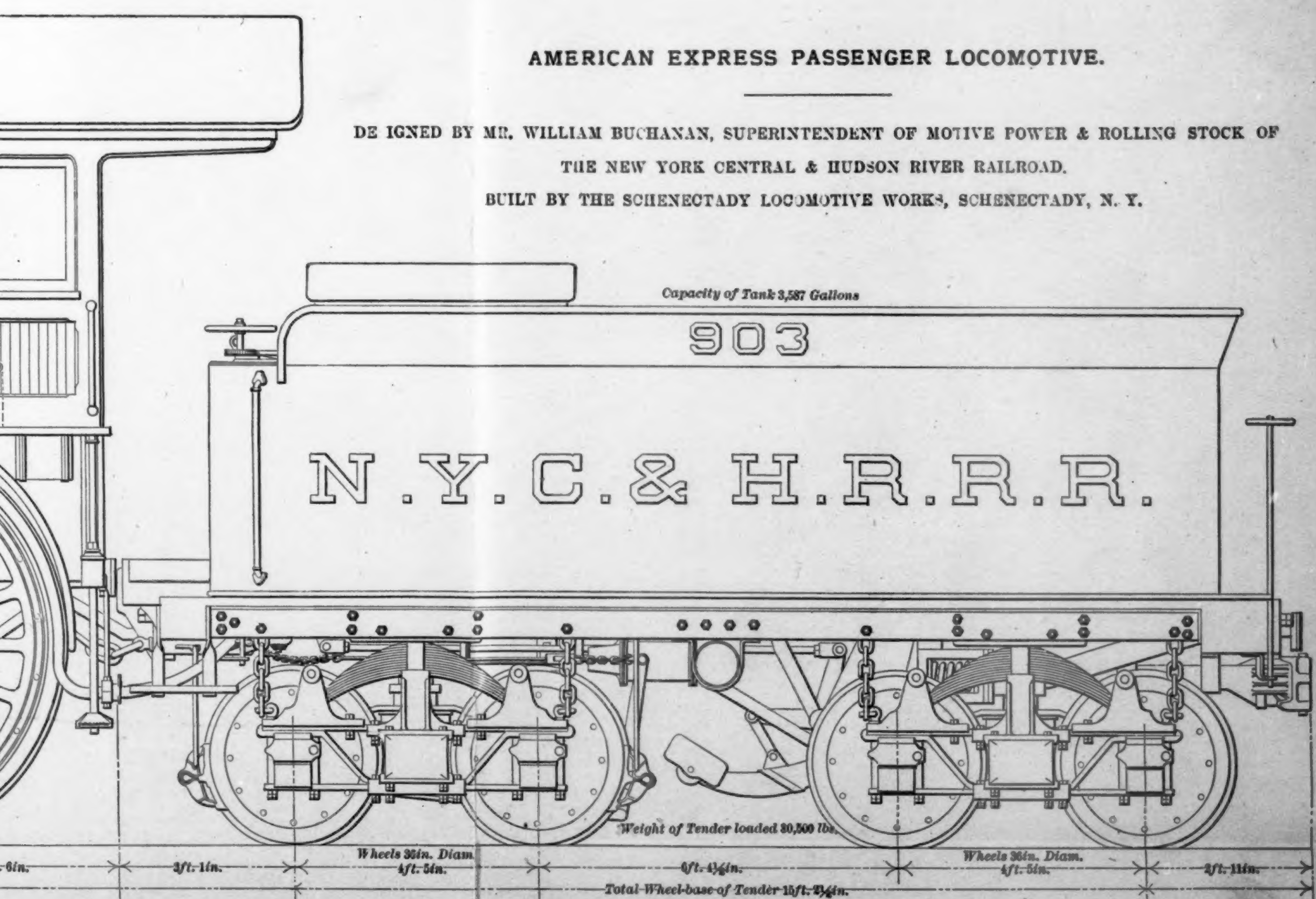
DE IGNED BY MR. WILLIAM BUCHANAN, SUPERINTENDENT OF MOTIVE POWER & ROLLING STOCK OF THE NEW YORK CENTRAL & HUDSON RIVER RAILROAD.

BUILT BY THE SCHENECTADY LOCOMOTIVE WORKS, SCHENECTADY, N. Y.



for various mechanical purposes by means of electric transmission. From figs. 1 and 2 it will be seen that the power station is located at the foot of the incline, water being supplied by three lines of 36-in. pipe, 1,300 ft. in length, delivering water to the wheels under a head of about 100 ft.

The canal extends 1.6 miles from the foot of the incline to the Kamagawa River, with which it connects by a lock.

The canal has been built for a moderate sum, the whole cost not exceeding $1,250,000. The works were designed by Mr. Sakuro Tanabe, Professor of Civil Engineering in the Imperial University, and were executed under his supervision.

THE LOCOMOTIVE PROBLEM AGAIN.

In the Railroad and Engineering Journal for April last there was given the following

PROBLEM.

Let it be supposed that the stroke of the pistons of a locomotive is 2 ft., the diameter of the driving-wheels 7 ft. and the speed 60 miles per hour; what is the maximum and minimum velocity of the piston relatively to the earth, and not with regard to the locomotive, and when does each occur?

Several answers were received to this and were published in the July, August, October and November numbers of the Journal; since then an additional reply has been sent in, which is given below:

X.—By Professor F. A. Weihe, Delaware College.

In solving this problem, the following assumptions have to be made: 1. That the speed of the locomotive is perfectly uniform. 2. That the cylinders are horizontal, and that a horizontal line passing through the axis of the cylinder passes also through the cross-head pin and the center of the wheel.

In fig. 8 let $A\,B$ represent the connecting-rod. The crank-pin will travel in the circle whose radius $= r = A\,O$ and

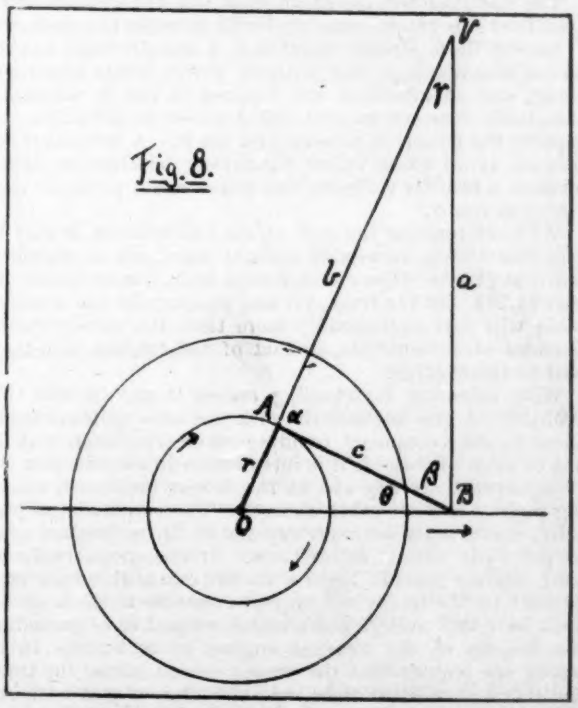


Fig. 8.

the cross-head pin B in the horizontal line $O\,B$. Find the virtual center V. The velocities of B and A will then be directly proportional to the virtual radii $V\,B\,(= a)$ and $V\,A\,(= b)$ respectively.

We have $\dfrac{a}{sin.\ \alpha} = \dfrac{b}{sin.\ \beta}$; $\therefore \dfrac{a}{b} = \dfrac{sin.\ \alpha}{sin.\ \beta}$. This will be a maximum when $\delta\left(\dfrac{a}{b}\right) = \dfrac{cos.\ \alpha}{cos.\ \beta} = 0$. This will be the case when $\alpha = 90°$. The velocity of B will therefore be greatest when the angle $O\,A\,B = 90°$. At this position

$$tang.\ \theta = \frac{r}{c} = cot.\ \beta = \frac{c}{b}.$$

Therefore $b = \dfrac{c^2}{r}\cdot$ Now

$$a^2 = b^2 + c^2 = \frac{c^4}{r^2} + c^2 = \frac{c^2}{r^2}(c^2 + r^2),$$

and

$$a = \frac{c}{r}\sqrt{c^2 + r^2}$$

$$\frac{a}{b} = \frac{\frac{c}{r}\sqrt{c^2 + r^2}}{\frac{c^2}{r}} = \frac{\sqrt{c^2 + r^2}}{c}.$$

By making $c = 3$ we have

$$\frac{a}{b} = \frac{\sqrt{10}}{3}, \text{ since } r = 1.$$
$$= 1.05409$$

Since the velocity of the locomotive is = 1 mile per minute, the crank will make $\dfrac{5280}{3.1416 \times 7} = 240.0970 +$ revolutions per minute, and the velocity of the crank-pin will be $= 240.0970 \times 3.1416 \times 2 = 1508.578$ ft. per minute.

The maximum velocity of the piston will therefore be

$= 1508.578 \times 1.05409 = 1590.1770 +$ ft. per minute.

Since the velocity of the locomotive with respect to the earth is 5280 ft. per minute, and since the maximum velocity of the piston will occur twice in every complete revolution, once in the same direction as that of the locomotive and once in opposite direction, we will have for the maximum velocity of the piston with respect to the earth 5280 + 1590.1770 + ft. per minute, and for the minimum velocity 5280 − 1590.1770 + ft. per minute.

Expressing this in a ratio, we have

$$\frac{\text{Max. vel. of pist. (same direct. as locomotive)}}{\text{velocity of locomotive}} = \frac{5280 + 1590.1770}{5280} = 1.301 +$$

$$\frac{\text{Min. vel. of pist. (op. to direct. of locomotive)}}{\text{velocity of locomotive}} = \frac{5280 - 1590.1770}{5280} = 0.698 +$$

THE NEW MANNLICHER RIFLE.

An article in the London *Daily News* gives some interesting statements in relation to a new gun which has been devised by Herr von Mannlicher, the inventor of the repeating rifle which has been adopted by the Austrian and Italian armies.

There is nothing particularly striking in the outward appearance of the new automatic repeating rifle. It possesses the ordinary characteristics of the various repeating systems now in use. The beautifully-finished models shown, however, are somewhat shorter than the latter, their dimensions being about those of an ordinary carbine, and their length 40 in. The weight, so important a factor, is slightly under that of an ordinary repeating rifle. The bore is 6.5 millimeters in diameter, the same as that of the latest Mannlicher pattern adopted by the Roumanian and Italian governments.

The rifle is a meter in length, while it is sighted up to 2,700 yards, and will carry a bullet 500 yards without loss of elevation; and its weight is less than an ordinary repeater.

The mechanism of the rifle consist of five essential parts, simple in detail and strongly made. First, there is the barrel containing the cartridge chamber; secondly, the locking lever, attached to the lower part of the barrel immediately underneath the cartridge chamber, and serving to engage and hold firm the third part—that is, the recoil and spring operated breech-bolt, when the cartridge is pushed home. The fourth part is the breech receiver, and lastly there is the trigger mechanism, which is so constructed that the shots may be fired in the most rapid succession or at any desired intervals. The mechanism, therefore, is simplicity itself.

With regard to the new weapon's performances, there was no space at disposal at the works for long-range firing. Descending into a big underground vault, bullets were fired,

or rather poured, into sandbags piled up against the base of a section of the huge fortification wall that was thrown round Vienna by Prince Eugene early in the eighteenth century. Herr von Mannlicher fired first, to show the handling of the rifle. The method of loading is the same as that practised with the ordinary Mannlicher repeater in Germany and Austria—the sure and practical clip containing five cartridges pressed downward into the magazine exposed to view when the breech-bolt is drawn back. A touch of the trigger of the automatic repeater, and the breech-bolt flies back upon its closed position.

Then followed five piercingly sharp explosions, and the empty clip dropped ringing from the magazine on the floor. The explosions seemed instantaneous. With a stop watch they were timed and found to occupy a *single second*. Barely 1½ seconds to come down from the "present" to the "ready" position, to insert another clip; and then five more shots banged forth in the same limit of time. There is no more recoil than in the case of a rook rifle. The mechanism seems to absorb the kick. The breech-bolt flies backward and forward at every discharge, ejecting the used-up smokeless powder cartridge, and pushing home a fresh one from the magazine. The eye cannot follow the movement, so instantaneous does it seem. And there is no escape of gas. In the hands of its inventor the rifle can discharge about 120 rounds per minute. The barrel becomes hot, but not so hot as to render the rifle useless for a time.

According to Herr von Mannlicher, his automatic rifle is not at the present time suited for general use by infantry, on account of the difficulties still encountered in supplying ammunition to the rank and file in the field in quantities sufficient to satisfy the demands of this cartridge-swallowing monster. It might, moreover, be a risky experiment to place in the hands of a soldier a rifle that can easily expend in one minute 100 rounds out of the supply of 150 that he carries in his cartridge pouches. Herein lies a serious difficulty, for every one knows how apt soldiers are to lose their heads and blaze away. On shipboard, however, when, for instance, sailors on an ironclad have to repel a torpedo-boat attack, the rifle would be extremely serviceable. The men could, with plenty of ammunition lying beside them, pour out bullets like a hailstorm. In such circumstances the fire from these rifles would be terrible, because after the first shot the aim need not be changed from the object first sighted at.

A PLAN FOR LOCOMOTIVE SHOPS.

At a meeting of the New York Railroad Club, held on October 27 last, Mr. M. N. Forney read a paper on a proposed plan for shops for building and repairing locomotives. A plan of the shops accompanied the paper, and is given in the accompanying illustration. The reasons for recommending the proposed plan is given in the paper as below.

The following seem to be the principal considerations which should govern the arrangement of shops in relation to each other.

1. Facility in moving material to and from them.
2. Facility of access from one shop to another. This should be in proportion to the amount of intercourse between them.
3. Materials should always be moved in the direction of their destination, and not backward and forward over the same route.
4. Safety from fire.
5. Facility of supervision.
6. Amount of railroad track required.
7. Facility of drainage.

These considerations will be taken up in the order in which they are named.

One of the chief problems of transportation in locomotive shops is how to move boilers, locomotives partly or completely finished, tenders, trucks and wheels from one shop to another, or from one part of a shop to another part. To do this a transfer table is usually employed. The impression is very general that such a table affords the most satisfactory means of transferring boilers, locomotives, etc., from one shop or part of shop to another. As there are some very grave objections to transfer-tables, and as locomotives and their parts may be handled with equal or greater facility with other means, some consideration will be given to the subject here.

Under any and all circumstances a transfer-table is the cause of a great deal of inconvenience. A pit of greater or lesser extent is required. This is an obstacle in the way of communication from one side to another. A wheelbarrow cannot be wheeled across it, nor a wagon and horse driven over it excepting on the table, which can only be at one place at a time. Walking across the pit is uncomfortable, especially when the hinges of the knee lack the lubrication of youth. Unless thoroughly drained, water accumulates in the pit when it rains, and it is filled with snow in winter, and is a receptacle of rubbish at all times and, excepting for the one purpose which it is intended to serve, it is a perpetual obstruction to free intercourse between some of the shops, and a nuisance generally. Happily, since the introduction of traveling cranes transfer-tables are not essential, if there is room enough to lay out the shops as may be desired. Boilers and engines can be moved inside the erecting shops with equal or greater facility with such cranes than they can be with the aid of a transfer-table, with the added advantage that a great deal of work can be done or facilitated by traveling cranes which cannot be done by a transfer-table.

If three tracks are arranged longitudinally in the erecting shop, with pits below the two outside tracks only, and the middle one is kept clear, the movement of the boiler and engines, and the handling of their parts by the traveling crane are very much facilitated.

By connecting the middle track with a turn-table outside of the shops, and then arranging the other buildings so that each of them may be connected with the turn-table, the transfer-table, with all its inconveniences, may be dispensed with.

Such an arrangement is shown in the plan herewith. In this the buildings are grouped around a central turn-table, which is connected directly with each of the shops, excepting the smith-shop and foundry, by a separate track.

The materials for the smith shop and foundry are delivered from side tracks connected with the main line as shown.

Besides those already mentioned, a transfer-table has the added disadvantage that separate power, either electric or steam, and an attendant are required to run it, whereas a turn-table does not require either power or attendant, excepting the person or persons who use it. A turn-table can be used at all times, either Sundays or holidays or nights, whereas a transfer-table requires either steam power or electricity to run it.

With reference to the cost of the two systems, it may be said that a 60-ft. turn-table without track, pit or masonry, will cost $1,500. The carriage for a 40-ft. transfer-table will cost $1,200, but the track, pit and masonry for the transfer-table will cost considerably more than the corresponding portions of a turn-table, so that of the two the turn-table will be the cheaper.

With reference to traveling cranes it may be said that probably no one acquainted with the uses of these appliances would recommend building an erecting shop without one or more of them, if it is intended to do work in it in the most expeditious way and at the lowest total cost, counting interest and all other charges. To serve their purpose fully, cranes must be made capable of lifting engines so as to put their wheels under them. If transverse tracks are used, engines must be lifted with one crane whose girder is parallel to the tracks and travels crosswise to them, and it must have two trolleys and a capacity equal to or exceeding the weights of the heaviest engines to be lifted. If the tracks are longitudinal the cranes extend across the track and travel parallel to them, and two cranes, each with one trolley and a capacity equal to half the weight of the heaviest engine, are required to lift it. As the concentrated weight of a single crane is greater than that of the two cranes, the structure on which the latter run may be lighter than is required for the single crane, so that probably the total cost of two light cranes and their supporting structures will be little if any greater than that of the single crane.

The use of two cranes has also the advantage that when not employed in lifting engines they can each be used simul-

taneously in doing other work in different parts of the shop, whereas one crane can be used at one place only.

It will also be shown further on that if the machine shops and machinery are arranged as contemplated in this paper, the cranes in the erecting shops can also be used for serving some if not all of the heavy machine tools.

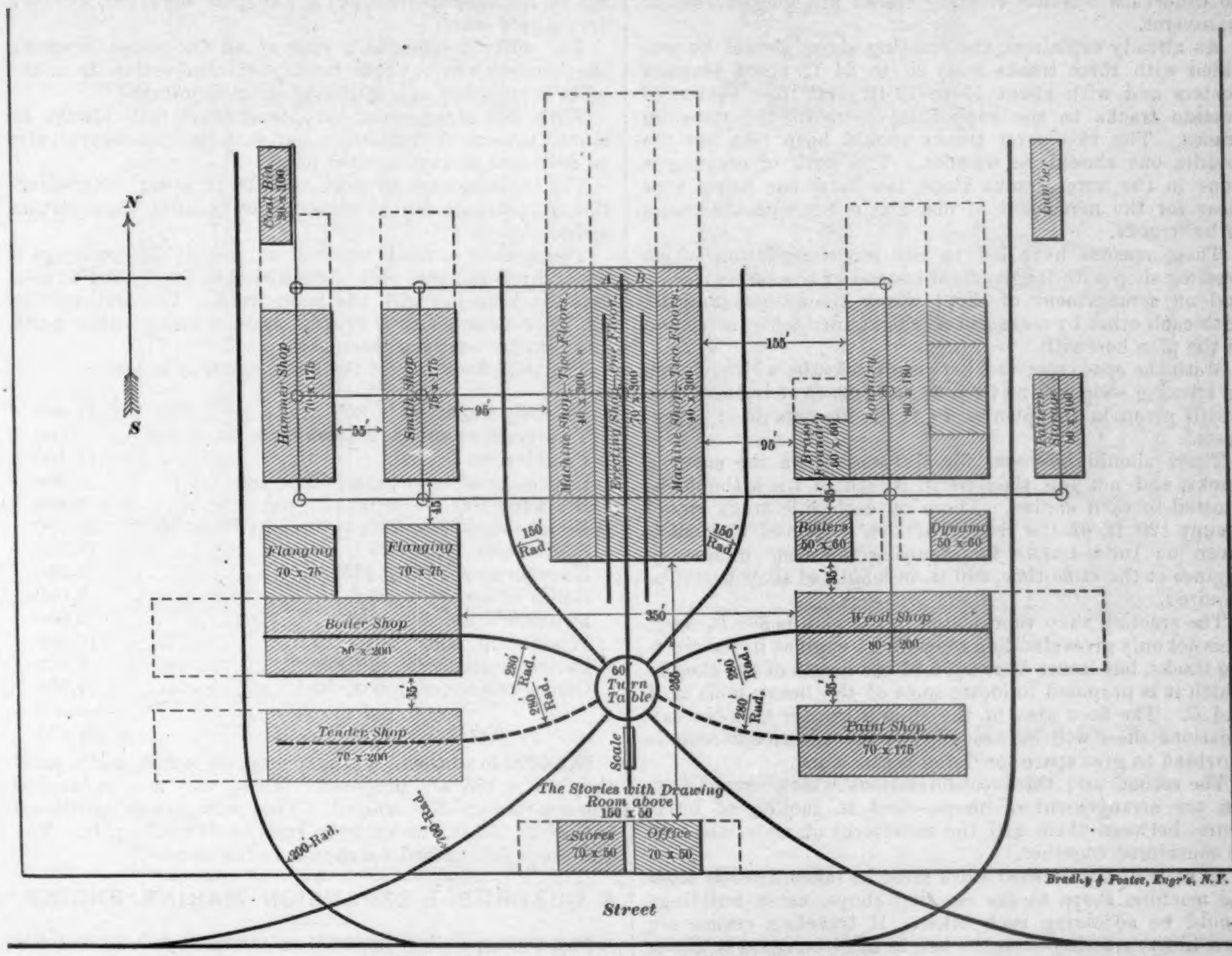
It has been suggested that a single light crane may be used for handling the parts of locomotives in an erecting shop with transverse tracks. It is doubtful whether any one who has ever seen the facility with which locomotives can be handled with cranes in an erecting shop would propose the use of appliances of that kind which would be too light to lift the heaviest locomotive. It is safe to say that the time required to do work with cranes would be counted by minutes, whereas if done without cranes it would be counted by hours.

The work done and the labor saved by the use of cranes in erecting shops is not, however, confined to lifting engines and boilers. In practice in shops equipped with these appliances every piece too heavy for a man to lift is handled with cranes, with a great saving of labor and time. As evidence of this, I submit the following letter from Mr. Joel West, Master Mechanic of the West Burlington shops of the Chicago, Burlington & Quincy Railroad, which are provided with cranes:

"Dear Sir: Some of the advantages of an erecting shop constructed with overhead cranes and longitudinal tracks in place of transverse pits, in my mind are as follows:

"All the material for the erecting of an engine can be brought from the finishing shops on rubble cars over small turn-tables and delivered at either end of the erecting shop, and the rubble car with its load can be picked up and taken to the point where the engine is to be erected, and each part can be handled from the rubble car directly on the engine; the engine frames and cylinders can be all bolted up and the boilers brought in in the same way from the boiler shop, and carried and dropped in its place after the frames and cylinders are all ready for the boiler, and all parts of the engine can be put into their places and the engine picked up as a whole, carried and set down at either end of the shop with water and steam put into the engine from a battery of stationary boilers, so that the engine is ready to go when she is set down at the door. If desired, as the engine progresses in her construction, she can be picked up in any stage of the erection and carried to any other part of the shop for the different men that are erecting the different parts. This avoids all outside transfer pits, which are very expensive in this country, from being blocked with snow, and put all the transfer work inside of the shop, where it is comfortable in all kinds of weather for men to work. It avoids a great many expensive side doors in a shop; makes a shop much warmer in winter and gives room where these doors would be located for work benches, heating apparatus, etc. I consider an overhead crane an indispensable necessity for handling all heavy parts of an engine. Two men can handle the cylinders, frames, decks, boilers, cabs, sand-boxes, dome casing, smoke-stack and the like, and put them in their places with all ease. In our shops we do not use jack-screws of any kind; an overhead crane is also an indispensable article in a tank shop, frame shop, as well as in a truck shop. It saves a great many tracks, as trucks can as well be put on a floor as anywhere else, and when completed can be carried to any track where they are wanted. Overhead cranes can be used in any part of the shop, while all such arrangements as drop pits can only be used for a small proportion of the work, while an overhead crane can be used for the largest or the smallest, and is not in the way of any one.

"I think that any one that sees the workings of an overhead crane in an erecting shop would not build a shop in any other way."



PLAN FOR LOCOMOTIVE BUILDING SHOPS.

If it is contemplated to do repairs as well as new work in

shops, such cranes will be especially useful, because in doing repair work locomotives must be taken off as well as put on their wheels, and the different parts must be taken down as well as put up.

Testimony to show the economy of time and labor in erecting locomotives by means of traveling cranes might be extended almost indefinitely. After diligent inquiry the writer has failed to find any one who has had experience in their use who has not been an earnest advocate of them.

The opponents of the system, as far as the writer's experience goes, are found only among those who have no practical knowledge of its advantages.

It may be added that, so far as convenience or facility of doing work is concerned, other things being equal, it makes no difference whether erecting tracks are longitudinal or transverse.

As already explained, the erecting shops should be provided with three tracks from 20 to 24 ft. apart between centers and with about 10 to 12 ft. clear from centers of outside tracks to the supporting posts of the traveling cranes. The two outer tracks should have pits, but the middle one should be without. The work of erecting is done in the outer tracks alone, the inner one being kept clear for the movement of material either with the cranes or by trucks.

These reasons have led to the recommendation of an erecting shop with longitudinal instead of transverse tracks, and an arrangement of shops whose tracks communicate with each other by means of a central turn-table, as shown in the plan herewith.

With the space specified between tracks the width of such an erecting shop will be from 60 to 72 ft. clear inside. The width given in the plan is 70 ft. to the outside of crane-posts.

There should be room for six engines on the erecting tracks, and not less than 40 ft. length of track should be allotted to each engine. Those on each side track would occupy 120 ft. of the length of the shop, and if room is given on those tracks for repairing the same number of engines at the same time, 240 ft. in length of shop would be required.

The erecting shop represented in the plan is 300 ft. long. This not only gives standing room for 12 engines in the erecting tracks, but leaves 50 or 60 ft. of the length of the shop in which it is proposed to locate some of the heavy tools at *A* and *B*. The floor area of the shop is greater than the calculations show will be needed, but the additional room is provided to give space for doing repair work.

The second and third considerations which should govern the arrangement of shops—that is, facility of intercourse between them and the movement of materials, will be considered together.

As most of the finished work must be taken directly from the machine shops to the erecting shops, these buildings should be adjoining each other. If traveling cranes are used in the erecting shop, its height must be equal to about two stories of an ordinary shop. With the use of elevators work can now be moved vertically as cheaply as it can be carried horizontally. Therefore the machine shops are placed alongside of the erecting shop, and if its sides are not enclosed by walls but only by posts to carry the structure and the traveling cranes, the machine shops may be arranged on each side of the erecting shop in the form of bays in the ground floor, and of galleries above the bays, as shown in the plan. This gives the greatest possible facility of intercourse between the machine shops and the erecting shops.

Suitable elevators must be provided for raising and lowering the work to or from the galleries. The floors of the galleries are supported from the roof, which leaves the lower floor clear of obstructions.

The heaviest tools may be located at *A* and *B* in the north end of the erecting shop, as indicated in the plan. In these two positions they can be served by the traveling cranes in the erecting shop. Balconies, either movable or fixed, may project from the galleries to receive work which is handled by the cranes.

The smith shop, it will be seen, is located on one side of the erecting and machine shops, and the foundry on the other. The distance—95 ft.—between the machine shops may be greater than is required, but can be reduced when the buildings are laid out on the ground. If it is reduced, the radii of the curves leading from the several shops to the turn-table must be made shorter.

With this arrangement work from the smith shop would be taken direct to the machine shop next to the smith shop, and castings from the foundry would be taken to the shop adjoining it. Naturally the heavy tools to do wrought-iron work would be placed next to the smith shop and those for cast-iron work will be next to the foundry.

The arrangement of the other shops is shown clearly in the plan. They are all grouped around the center turn-table, as shown, and all of them, excepting the smith shop and foundry, are connected with it. By this means work can be transported from any one shop to any other, and by a very direct route.

The office commands a view of all the shops excepting the hammer shop. This facility of observation from the office is regarded as a matter of some importance.

With this arrangement proposed, work will always be moved toward its destination, and material can conveniently be delivered at any required point.

The buildings are all more than 30 ft. apart. No reduction in insurance can be obtained by locating them further apart.

The amount of track required outside of the buildings is about 2,900 ft., and only three switches are needed to connect the branches with the main track. The drainage can all be conducted to a central drain running either north and south or east and west.

The total floor area of the buildings is as follows :

	Sq. ft.
Erecting shops, 70 × 300	21,000
Two machine shops, 2 floors each, 40 × 300	48,000
Foundry, 80 × 180	14,400
Cupola, sand-house, etc., 60 × 180	10,800
Brass foundry, 60 × 60	3,600
Boiler shop, 80 × 200, two wings 70 × 75	26,500
Smith shop, 75 × 175	13,125
Hammer shop, 70 × 175	12,250
Boiler house, 50 × 60	3,000
Dynamo house, 50 × 60	3,000
Wood shop, 80 × 200	16,000
Pattern storage, 50 × 100	5,000
Office, two floors, 150 × 50	7,500
Total	184,175

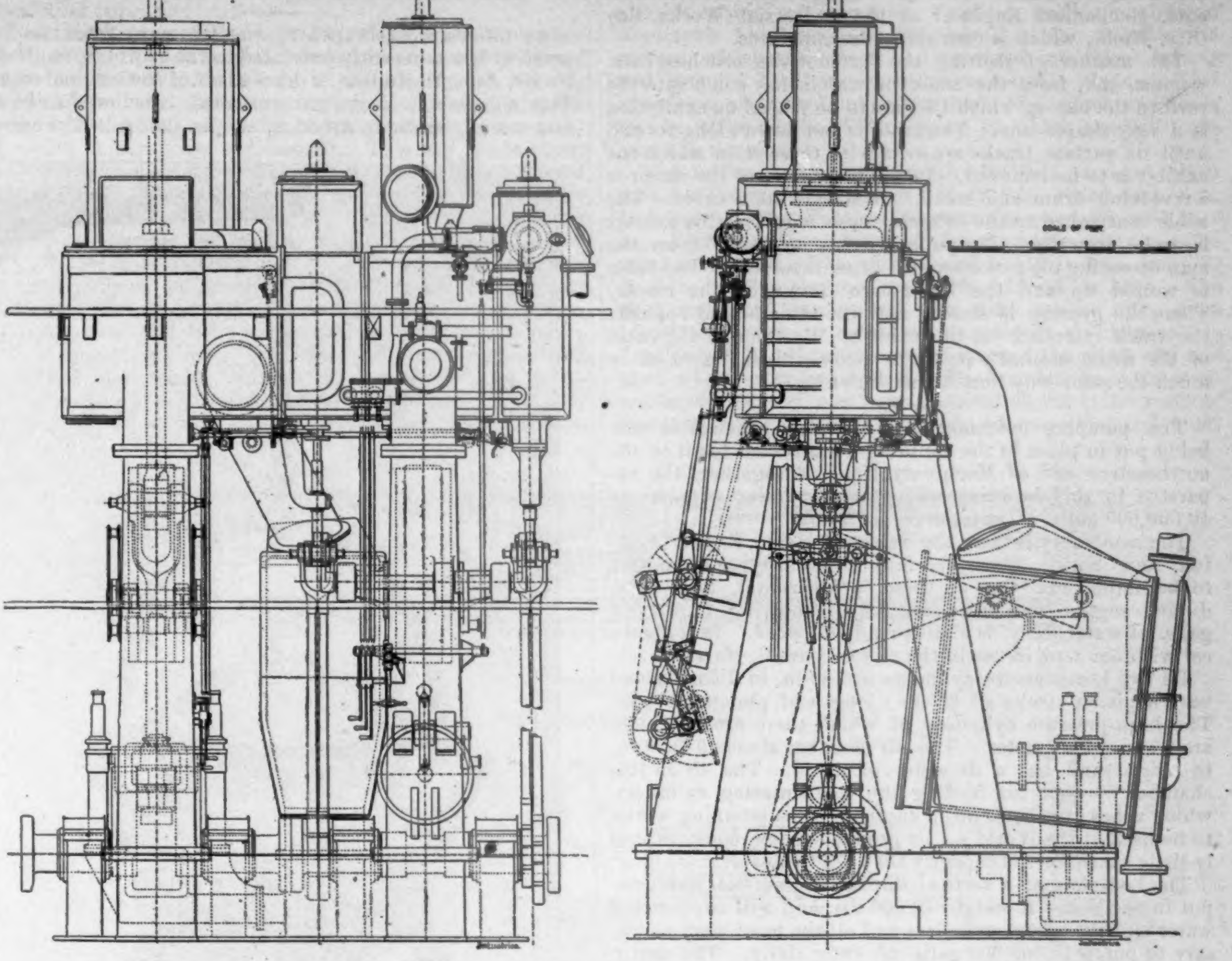
In addition to these, a tender shop, 80 × 200, and a paint shop 70 × 175 are proposed. These may not be needed when works are first started. They will give an additional area of 28,250 ft., making the total of 212,425 sq. ft. The two shops last named are shown on the plan.

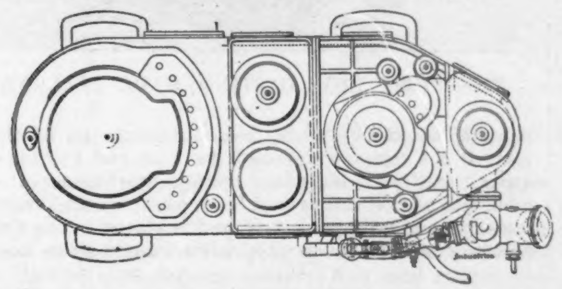
A QUADRUPLE-EXPANSION MARINE ENGINE.

The accompanying illustrations, from *Industries*, show a quadruple-expansion engine altered from an old compound engine in the works of Denny & Company, at Dumbarton, Scotland. The new engine is of a type designed by Mr. Walter Brock, having two cranks only, the high-pressure cylinder being placed above the first intermediate and the second intermediate above the low-pressure cylinder. In this design the lower or front heads of the two upper cylinders form the covers for the two lower ones, there is no stuffing-box exposed between the top and bottom cylinders, and no alteration to any of the original valve or other gear is required. Neither are the number of stuffing-boxes and glands increased after the transformation is complete, as the valves for the four cylinders are all situated in the casings of the two lower cylinders.

The engines shown were built for the steamship *Duke of Westminster*, now running in a line owned by the New Zealand Shipping Company. The vessel was built in 1882, is 400 ft. long, 40.3 ft. beam and 28.7 ft. depth of hold.

The old engine was of the ordinary compound surface-condensing type, with cylinders 43 in. and 86 in. × 54 in. stroke. Steam was supplied by three double-ended boilers working at a pressure of 75 lbs. As altered there are two double-ended boilers, working at 160 lbs. pressure ; they are fitted with the Howden forced-draft apparatus, and





QUADRUPLE-EXPANSION [MARINE ENGINE.

BY DENNY & COMPANY, DUMBARTON, SCOTLAND.

supply steam for two engines running the refrigerating machinery of the ship, as well as for the engine described. The cylinders of the new engines are 25½ in., 38 in., 51 in. and 73 in. × 54 in. stroke; the ratios of the high-pressure cylinder to the others are thus 1 : 2.22 ; 1 : 4.00 and 1 : 8.20.

On the trial trip after the new engines were completed the mean speed was 13¼ knots an hour in a run of several hours. The power developed by the engines, as computed from diagrams taken while running at the speed named, was: First cylinder, 636 ; second, 599 ; third, 596 ; fourth, 732 ; total, 2,563 H.P. This is an increase of about 40 per cent. over the old compound engine.

The ship is a freight carrier, not built for speed, but since the change of engines has made one trip in which she showed a greatly improved performance, with a saving in fuel.

Denny & Company have built a considerable number of quadruple-expansion engines of the same general type.

COLUMBIAN EXPOSITION NOTES.

THE great transfer table, which is to be used in running the locomotives and coaches of the transportation exhibit on to their respective tracks, is now completed. It is about 70 ft. in length, and will travel on seven pairs of wheels. The tracks upon which it will ply are situated about 2 ft. lower than the tracks to be occupied by the exhibits. This allows the track on the surface of the transfer table to come on a level with those on which the exhibits are to be shunted.

Extending about three-fourths of the length of the transportation annex is a cut in the flooring about 2 ft. in depth and 70 ft. in width. Seven rails are laid its entire length, and it is on these that the transfer table will travel.

The table will have a carrying capacity of 100 tons. It will be operated by electricity, and one man will have complete control of it. According to the amount of weight on it the table can be made to travel back and forth at a speed varying from 120 ft. to 225 ft. per minute.

A dynamo of 30 H.P. operates the machinery. The dynamo and gearing are on a small platform attached to the car at its center. The electricity operating the dynamo is carried to it through two protected wires placed within a few inches of the ground on which the traveling table rails are laid. The dynamo is of the Thomson-Houston make, and the method by which the electricity is carried to it by the wires is known as the double trolley system. The electricity will go around the circuit of the wires and back to where it is generated. The rails will, therefore, not require to act as return circuits for the electric fluid as in the street

car electric systems. The car is designed by W. L. Clements, Mechanical Engineer of the Industrial Works, Bay City, Mich., which is furnishing the apparatus.

The manner of shifting the locomotives, coaches, cars, wagons, etc., from the track on which they come into the yard to the one on which they are to be placed on exhibition is a very simple one. The table is run down along its bed until its surface tracks are even with those from which the exhibit is to be removed. In the machinery of the motor is a revolving drum and small, but strong, steel cable. The cable is attached to the locomotive, or whatever the exhibit is, to be drawn on. By pulling down on a small lever the man operating the motor sets the drum revolving. The cable is wound up and the locomotive drawn on the tracks. Then the gearing is started and the table placed opposite the track intended for the exhibit. By running the cable of the drum around a post the locomotive is drawn off in much the same way that it was drawn on.

THE pumping machinery for the Fair grounds is now being put in place in the building constructed for it at the northeastern end of Machinery Hall. Altogether, the apparatus in this building will have a pumping capacity of 40,000,000 galls. of water every 24 hours.

The machinery is from the works of Henry R. Worthington, New York. There are four different types of engines to be employed. One of these, a horizontal, high-duty, duplex engine with a capacity for supplying 12,500,000 galls. of water daily, is almost ready for work. It is identical with one now in use in the city of Lowell, Mass.

Its two low-pressure cylinders are 50 in. in diameter and have a piston stroke of 28 in.; length of plunger, $27\frac{1}{2}$ in. The high-pressure cylinders, of which there are also two, are 25 in. in diameter. The air chamber stands 6 ft. 6 in. in height and has a diameter of 40 in. The air in this chamber is used for feeding the compensating cylinders, which act as fly-wheels do on engines. The pumping works to be used at the World's Fair grounds occupy comparatively little space for the capacity they are to develop.

The bed-plate of a vertical duplex engine has just been put in position. It weighs 40,000 lbs. and will support the water and the steam cylinders and all the machinery necessary to pump 15,000,000 galls. of water daily. The entire height of this will be 49 ft. $2\frac{1}{2}$ in. Of this 10 ft. will be below the floor proper.

The suction pipes of both engines are 30 in. in diameter and the delivery pipes into which the water is forced from all the four engines are 46 in. in diameter. In the center of the building is a well about 18 ft. in diameter from which the suction pipes draw the water. The well is connected by a tunnel with the main lagoon, and the water is to be used in the fountains, etc.

The two other engines of the pumping station are a triple-expansion vertical condensing engine and a high-speed engine with a capacity of 5,000,000 galls. a day.

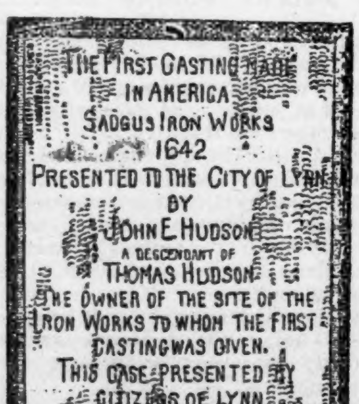
A RECENT Washington dispatch says that it is the intention of the Geological Survey in its exhibit at the World's Fair to elucidate the geology of the United States, which will represent its work in both the field and the office. Mineralogy in the United States will be shown as perfectly as possible, mainly by selected specimens, and not a large mass of material from any of the localities. Rocks of the United States will be shown as an educational collection. There will be displayed cases of American fossils, so arranged as to show both their distribution in the United States and their order of geological column. In connection with these will be included restorations of some of the enormous fossil animals discovered by Professor Marsh. Office work of the Survey will be illustrated very largely by photographs, photographic transparencies, maps and drawings. With these will be displayed the instruments used in the work of the Survey, together with a series of enlarged relief maps, constructed to show the geology and topography of the country. In addition to the collections having a purely scientific value, a collection will be prepared to show, by direct association of specimens, descriptive labels and maps, the economic resources of the United States, including ores and other minerals of commercial value, arranged so as to illustrate at a glance the wealth of the United States as regards each particular class of objects.

THE FIRST IRON WORKS IN AMERICA.

AN interesting relic, which was for many years carefully preserved, was recently presented to the city of Lynn, Mass., by Mr. John E. Hudson, a descendant of the original owner. This relic, which is well authenticated, is believed to be the first casting made in America, and is shown in the accom-

THE FIRST IRON CASTING MADE IN AMERICA.

panying engraving, made from a photograph of the original. It is a kettle, weighing 2 lbs. 4 oz. and holding about a quart, and the somewhat rough workmanship of the moulders of that day is well brought out in the photograph. It will be carefully preserved, and is placed in the Lynn city hall in a case, the back of which is formed by an iron tablet



bearing an inscription, which is shown in the second illustration. This tablet illustrates the skill of the iron founders of to-day, and is used just as it came from the foundry, untouched by tools; it has been treated by the magnetic oxide process to guard against corrosion. The groundwork

is a woven bamboo pattern upon which the letters of the inscription appear.

The formal presentation to the city was made November 22, when Mr. Hudson made a brief address, to which Mayor Hayes responded. Mr. C. J. H. Woodbury, of Boston, then made a very interesting historical address, giving an account of the first beginning of iron working in America, of which this relic is a memorial. This was made about 1642 at the Saugus Iron Works near Lynn, where a blast furnace was established to work the bog ore found in the meadows along the Saugus River. To this was added later a forge or bloomary for making wrought iron from the pig iron of the blast furnace, and it is known that steel was also made there. A machine shop afterward formed part of the works. The head and manager was Joseph Jenks, who seems to have been an accomplished workman and a man of much ingenuity. He built the first fire-engines used in Boston, he invented a saw-mill and a new form of water-wheel, and to him is due the form of scythe now universally used—long and narrow, stiffened by a ridge along the back —which speedily replaced the broad, short bushwack scythe previously in use.

Water-power was used to run the works, where cannon were cast at one time, and a fairly prosperous business was done. In the blast furnace charcoal was used as fuel, and lime obtained from oyster-shells as a flux. Some prominent persons in the colony were interested in the works from time to time, and they are frequently mentioned in the old records. They were undoubtedly of great use in gathering and educating skilled mechanics, and in showing the possibility of making iron in the new country.

The works were in operation over 45 years, and seem to have been closed about 1688, when it is probable that the supply of bog ore accessible was nearly exhausted.

It seems to be historically established that the Saugus Iron Works were the first in America to go into successful operation. Iron ore was mined by the colonists in Virginia at an early date, and an attempt was made to establish a furnace near Jamestown in 1622, but it failed on account of Indian troubles.

We are indebted to Mr. Woodbury for the photograph of the casting, and to his excellent address for the facts briefly noted above.

THE GARIBALDI BRIDGE AT ROME.

The accompanying illustrations show the Garibaldi Bridge at Rome, which crosses the Tiber near the historical island called Isola Tiberina, which is said to have been formed by the mass of grain plundered by the population in a revolt against the Tarquins. Tradition has it that the god Esculapius hid himself in this island in the disguise of a serpent, which the priests had captured in a Greek temple and brought to Rome in order to avoid a plague. This island was afterward cut to the shape of a vessel, and there was built the temple of Esculapius, of which are still to be seen the remains.

The bridge has a total length of 470 ft., and is formed with two large iron arches of 173 ft. 8 in. chord and 16 ft. 4 in. pitch. The distance between the parapets is 65 ft. 6 in. Each span is composed of 13 arched ribs, and the pavement is of stone. The central pier is 110 ft. 6 in. long, 39 ft. 3 in. wide at the top, and 46 ft. wide at the base. The abutments and the central pier were put in place upon foundations sunk by means of compressed air caissons to a depth of 50 ft. below low-water level of the river, and rest upon a layer of compact sand. The foundations of the abutments and central pier have required 29,925 cubic yards of masonry, while 2,930 cubic yards of *travertino* and 1,007 cubic yards of Baveno granite have been used for the ornamental portions.

The weight of iron used in the construction of the two arches is 1,680 tons. A maximum load of 880 tons on the bridge gives a stress of 8,450 lbs. per square inch on the iron-work. This bridge cost about $720,000, of which $200,000 has been expended upon iron-work. At the two ends of the bridge there are four granite columns of the ancient *miliarie* form, bearing in bronze the dates of the principal campaigns of Garibaldi—Montevideo, 1847; Roma, 1848; Varese, 1859; Marsala, 1860; Volturno, 1860; Bezzecca, 1866; Mentana, 1867; Digione, 1871.

This bridge was designed by Signor Angelo Vescovali, who holds the position of Chief Engineer of the hydraulic service of the city of Rome—who designed the Margherita and Magliana bridges—and the works have been executed under his supervision by Messrs. Zschokke & Terrier. The iron-work was supplied by Messrs. Tardy & Benech, of Savona.

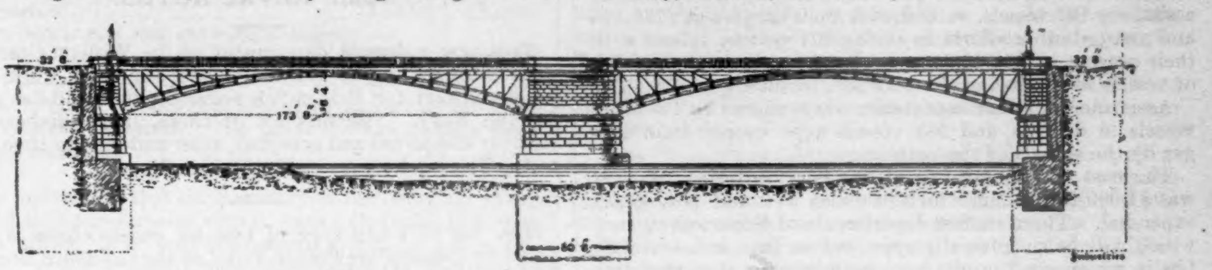
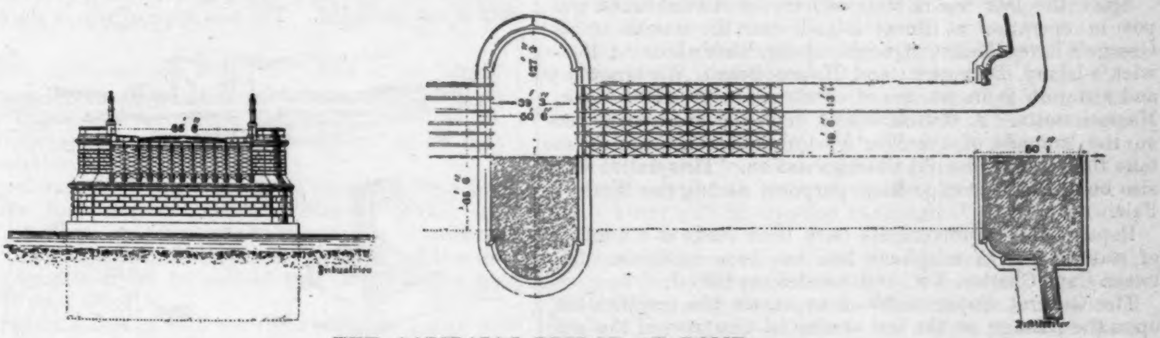


Fig. 1.—Side Elevation of Bridge



THE GARIBALDI BRIDGE AT ROME.

THE LIFE-SAVING SERVICE.

The General Superintendent of the United States Life-Saving Service, in his report for the year ending June 30 last, states that there were at the close of the fiscal year 242 stations, 181 being on the Atlantic, 48 on the Lakes, 12 on the Pacific and one at the Falls of the Ohio, Louisville, Ky.

The number of disasters to documented vessels within the field of the operations of the Service during the year was

337. There were on board these vessels 2,570 persons, of whom 2,550 were saved and 20 lost. The number of shipwrecked persons who received succor at the stations was 747, to whom 1,847 days' relief in the aggregate was afforded.

The estimated value of the vessels involved in the disasters was $5,584,160, and that of their cargoes $2,700,365, making a total value of property imperilled $8,284,525. Of this amount $7,111,005 was saved and $1,173,520 lost.

The number of vessels totally lost was 59.

In addition to the foregoing there were during the year 170 casualties to small craft such as sail-boats, row-boats, etc., on which there were 353 persons, 346 of whom were saved and 7 lost. The property involved in these instances is estimated at $67,810, of which $63,470 was saved and $4,340 lost.

In addition to the number of persons saved from vessels there were 36 others rescued who had fallen from wharves, piers, etc., and who would have perished without the aid of the life-saving crews. The crews saved without outside assistance 167 vessels, valued with their cargoes at $736,345 and assisted other efforts in saving 101 vessels, valued with their cargoes at $2,942,340, making the aggregate number of vessels saved during the year 268, involving $3,678,685.

Assistance of minor importance was rendered to 213 other vessels in distress, and 265 vessels were warned from danger by the signals of the patrolmen.

The cost of maintenance of the Service during the year was $1,009,234, a sum which has been well and judiciously expended. There are few departments of Government work which will be so generally approved as this, and certainly few in which good results have been secured at so moderate a cost.

Since the last report stations have been established and put in operation at Burnt Island, near the mouth of St. George's River, Maine; Quonocontaug, Rhode Island; Fenwick's Island, Delaware; and Ilwaco Beach, Washington; and a station is in process of construction at Brant Rock, Massachusetts. A station is also in course of construction on the grounds of the World's Columbian Exposition, to take the place of the old Chicago station. This station will also be utilized for exposition purposes during the World's Fair.

Repairs and improvements have been made at a number of stations, and a telephone line has been established between Cape Charles, Va., and Assateague Island.

The General Superintendent expresses his gratification upon the passage at the last session of Congress of the act increasing the compensation of the keepers and surfmen during employment at the stations. He states that its good effects are already apparent in the fact that in all instances men of the very best qualifications for the work of the Service are now obtainable, and the officers in charge find themselves able to dispense with some inferior men whom the rate of compensation formerly prevailing compelled them to take. Moreover, the men accept with greater cheerfulness the hardships and privations of their calling, and an improved *esprit de corps* throughout the Service is obvious.

THE NATIONAL LEAGUE FOR GOOD ROADS.

In reply to many inquiries, the National League for Good Roads makes the following statement of its plans for work:

1. To combine, as far as practicable, the efforts of all persons now engaged in the work for road reform.
2. To awaken interest in the subject among the people at large.
3. To receive, publish and discuss any well-considered plans for local, State or national action or legislation.
4. To urge the passage by the House of Representatives of the Senate's bill for a national highway.
5. To aid in providing for a proper road exhibit and for free instruction in road making at the World's Fair in Chicago.
6. To establish the league upon the broadest possible basis throughout the country, so that its influence may be of weight in any direction in which it may ultimately be thrown.

The temporary management does not feel authorized to adopt any line of policy nor commit the league to any special scheme which might antagonize the partisans of others, and thus defeat its immediate purpose to unite and solidify the movement.

The immediate formation of county leagues is recommended as a step toward the spread of the organization into township and school districts. County secretaries will be appointed by the State roads upon the recommendation of prominent citizens.

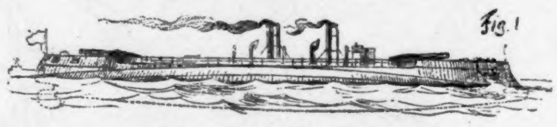
Until the State boards are fully organized all correspondence will be conducted through the General Headquarters, 45 Broadway, New York.

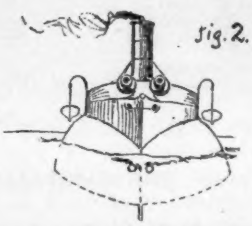
All State, county and local leagues are at liberty to act independently in local matters of road improvement, and will be supported by the national organization as far as is practicable and proper.

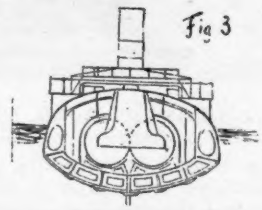
HOME NAVAL NOTES.

The new ordnance department of the William Cramp & Sons Ship & Engine Building Company is at work on a large contract for Driggs-Schroeder 6-pdr. rapid-fire guns for the Navy. The first lot of these, 12 in number, was recently completed and accepted, after undergoing the usual test. The 6-pdr. guns are 2.224 in. caliber.

The use of a new type of ram for coast defense is proposed by Commodore Folger, Chief of the Ordnance Bureau. The proposed ship differs from the Ammen ram somewhat in form, and also in carrying guns, with which the Ammen ship is not provided. The new type of ram is shown in the







accompanying sketch, fig. 1 being a side view; fig. 2 a view of the bow, on a larger scale, and fig. 3 a cross-section amidships. It will be seen that the ship somewhat resembles the whaleback type in general form. She would be protected by water-line armor and a heavy curved deck. A ship of this type 275 ft. long and 45 ft. beam would have about 2,700 tons displacement. As a ram she would, of course, carry heavy engines, capable of giving her a speed of 18 or 19 knots. The armament proposed for such a vessel is four 9-in. or 10-in. rifled mortars, intended to carry shells loaded with high explosives; also two Ericsson submarine guns of 12-in. or 15-in. caliber. The vessel, in fact, seems to be intended to combine the qualities of a ram and a torpedo-boat.

The transfer boat *Ann Arbor*, No. 1, built to carry cars across Lake Michigan, has been inspected, and will probably be enrolled as one of the reserve vessels of the Navy. This boat, which was described in the Journal for November last, is especially suited for naval work. The heavy main deck, built to carry loaded freight cars, is well adapted for heavy guns, while the great strength of the hull and the wooden backing extending for 30 ft. from the bow, meant to enable her to break through the ice in winter, will, with her twin screws and powerful engines, make her a formidable ram, should her services ever be needed in a warlike way. She is also sheathed along the water-line with heavy boiler-plate, and has room for a large coal supply and a numerous crew.

The bids for the construction of the armored cruiser *Brooklyn* and the battle-ship *Iowa* were opened at the Navy Department, December 15. The *Brooklyn* is to be very similar to the *New York*, and the *Iowa* to the three battle-ships now under construction; but some modifications were made in the designs from the earlier types, and the battle-ship is larger.

Four firms presented bids, all being made on the designs prepared by the Navy Department, except as noted. These bids were as follows:

	Brooklyn.	*Iowa.*
Bath Iron Works	$3,165,000	$3,185,000
Newport News Shipbuilding Co.	3,147,000	3,233,300
Union Iron Works, San Francisco	3,050,000	3,150,000
William Cramp & Sons Ship and Engine Co.:		
1. On Department designs	2,986,000	3,010,000
2. With quadruple-expansion instead of triple engines	3,086,000	3,110,000
3. On lines of *New York* and *Indiana* respectively	2,880,000	2,880,000

The Newport News Shipbuilding Company appears as a bidder for the first time. The other bidders all have naval work on hand.

It is understood that the Secretary of the Navy has at last decided that the *Vesuvius* should have a thorough trial with loaded shells. The previous partial trials for range and accuracy of the dynamite guns have been made with dummy or unloaded shells, but in the new trials a considerable number—75, it is said—of loaded shells will be used, and a full opportunity for testing their efficiency will be given.

The report of Commodore Farquhar, Chief of the Bureau of Yards and Docks, states that permanent improvements have been made at several of the navy yards, although the appropriations have not been large enough to do all that appears desirable.

The report says that there is a great necessity for a dry dock on the New England Coast capable of taking the largest battle ships, and he points to the possibly disastrous results of a naval combat off that coast without facilities for repairs. The same could be said of the necessity of a dry dock on the Gulf Coast.

In the report stress is laid upon the necessity for an increase in the number of civil engineers to meet the demands of the service, and legislation is suggested looking to the increase of the corps to twenty, twelve to be civil engineers and eight to be assistant civil engineers, the assistants to be selected from graduates of the Naval Academy showing an aptitude for civil engineering and given a course in some civil engineering school. Vacancies in the grade of civil engineers should be filled by promotion from the grade of assistants, after examination.

The annual report of Engineer-in-Chief George W. Melville shows the large amount of work done by the Bureau during the year in construction of new engines and in designing machinery for the new ships which have been authorized. The engines for the *Brooklyn* have already been described, and the other work has been referred to from time to time.

Mr. Melville recommends an appropriation of $25,000 for experiments with liquid fuel, in view of the many considerations in favor of the use of such fuel in ships. He also recommends that the present compound engines of the *Chicago* be replaced with new ones of a more modern type, which will add largely to the efficiency of the ship, and can be made to increase her speed, with considerably less weight and space than the present machinery.

The report renews the recommendations of last year for an increase in the number of engineer officers. Notwithstanding the greater variety of machinery on the new ships, the number of engineers has not been increased, and the amount of work and responsibility has become too great to permit a proper distribution. The need of more engineers is urgent for the ships already completed, to say nothing of those approaching completion; and the present law does not take account of the fact that the modern naval vessel depends upon her engineers almost entirely for her efficiency. Mr. Melville speaks plainly in his report, and his argument is a strong one. An increase in the number of machinists and petty officers in the engine-room is also much needed.

The report of the Chief of the Bureau of Ordnance gives at length an account of the armor tests which have been from time to time described in our columns. In view of the results obtained in these tests it is believed that the tendency manifested abroad to decrease the caliber of the larger guns is to some extent unwise, and that great mass in the projectile will still be required to pierce the best qualities of armor as now made.

Of the 381 guns, of calibers from 4 to 13 in., required, 237 have been completed and 116 are already afloat.

The first 13-in. gun is approaching completion, and the forgings for a second one have been received.

Five 12-in. guns have been completed, of which two have been proved and are being installed on the *Monterey*. The test of this caliber upon the firing ground was entirely satisfactory.

All the 10-in. guns required have been completed and are ready for installation on the ships to which this caliber has been assigned.

A marked step in advance has been made in the application to the 10 in. and 12-in. guns of a device for operating their breech closure by hand. After considerable trial and experiment a simple and efficient mechanism has been developed, and thereby not only is the rapidity of fire of these heavy guns considerably increased, but the apparatus for working them is much simplified. The serious disadvantages attending the use of power, whether hydraulic, electric or other, in the working of naval ordnance are now generally recognized, and, as far as practicable, the Bureau proposes to use hand power for operating heavy guns.

All the 6-in. guns required to arm ships building or authorized have been completed, but the Bureau has contracted for forgings for six 6-in. guns of 40 calibers length of bore, which it proposes to make rapid-fire guns, using brass cartridge cases similar to those of the 4-in. and 5-in. rapid-fire guns. These will be supplied to certain of the fast cruising vessels.

The metallic cartridge cases now adopted for the 4-in., 5-in., and 6-in. calibers will probably before long be applied to the larger calibers as well. The Bureau is convinced that it is merely a question of time before this innovation will be a definitely recognized necessity in the military services of all nations. The advantages of doing away with the obturator, of eliminating sponging, of replacing present powder tanks in the magazines by cartridge cases as fixed ammunition and the increase in rapidity of fire are too obvious to need discussion.

The manufacture of brown powder for the Navy has been continued. No changes in the requirements of the powder have been made, 2,000 feet-seconds, 2,100 feet-seconds, and 2,175 feet-seconds, respectively, being demanded in guns of 30, 35, and 40 calibers length of bore, the maximum pressure in no case to exceed 15 tons per square inch. With these requirements powder is supplied without difficulty for the guns of 8-in. caliber and less, and for 10-in. guns enough powder has been accepted to supply ships completed, but as yet no entirely satisfactory 12-in. powder has been tested. The difficulty would undoubtedly be removed by allowing an increase of pressure to 17 tons, and this is the usual limit abroad; but the Bureau prefers not to do this on account of the considerable increase of the gun's life which will result in the use of only moderate pressures, and it is thought that finally powder up to the specifications will be supplied for the larger calibers with as uniform success as it already is for the smaller.

Since the last report marked progress has been made in the development of the Navy smokeless powder. At that date tests had been made only in small arms—3-pdrs. and 6-pdrs., and once in the 4-in. rapid-fire gun. During the past year 1,500 lbs. of smokeless powder, made at the torpedo station at Newport, have been tested in various ways with most gratifying results.

The square flat grains first used have been given up and the macaroni form adopted, the diameter of the sticks vary-

ing from $\frac{1}{16}$ in. for the small arms to about 0.2 in. for the 6-in. gun, and the larger of the sticks being perforated. Repeated experiments have further demonstrated the stability and safety of this powder. One portion placed in an iron vessel, wrapped in felting and exposed to a temperature of 208° Fahrenheit for six hours, was absolutely unaffected; another, similarly treated, stood a temperature of 212° Fahrenheit for 20 hours before showing signs of change; a third sample exposed to a temperature 5° below zero, Fahrenheit, was likewise unaffected. Attempts to detonate this powder by the service detonator, when closely confined in iron cylinders, have failed, though the cylinders themselves were ruptured and the powder scattered.

Other features treated by the report are the use of emmensite as a high explosive bursting charge for shells, the manufacture of armor-piercing projectiles, the fire of submarine guns, and the development of torpedoes.

THE gradual disappearance of the wooden vessels of the old Navy is forcibly shown in the annual report of Chief Constructor T. D. Wilson.

During the past year the *Pensacola* and *Iroquois* have been put out of commission, and the *Tallapoosa* condemned and sold. The *Kearsarge* and *Hartford* have been exempted from the operation of the 10 per cent. limit for repairs. There are only nine wooden steam vessels in active cruising service—viz., *Lancaster*, second rate; *Marion*, *Mohican*, *Kearsarge*, *Adams*, *Alliance*, *Essex*, and *Thetis*, third rate, and *Yantic*, fourth rate. The following vessels are in ordinary subject to the action of the Department: *Pensacola*, *Omaha*, *Swatara*, and *Iroquois*, all of which are at the Navy Yard, Mare Island. During the past year the *Nipsic* has been fitted out as quarters for officers on duty at the new naval station on Puget Sound. The *Enterprise* is to be turned over to Massachusetts as a nautical schoolship. The only wooden vessels remaining on active duty are the *Portsmouth* and *Monongahela*. The *Monongahela* has been completely overhauled during the past year, has had a spar deck added, and is now a most efficient and serviceable training vessel. The *Jamestown* has been found unfit for further active service, and is now being temporarily used as a hospital ship at Cape Charles, Va. The progress of work on vessels under contract and those building at Navy yards is on the whole satisfactory, but, in many instances, has been greatly impeded by the delay in supplying armor-plates. It is believed, however, that the contractors for armor are now in a position to fulfil their contracts with greater rapidity and that delay from this source will soon disappear. Fourteen new vessels, including three tugs, were launched during the year — the *Detroit*, *New York*, *Montgomery*, *Machias*, *Narkeeta*, *Wahneta*, *Iwana*, *Raleigh*, *Bancroft*, *Castine*, *Texas*, *Columbia*, and *Marblehead*. The tugs *Iwana*, *Wahneta*, and *Narkeeta* have had successful trial trips and have been accepted by the Navy Department. The others are in an advanced state of progress and, with the exception of the *Texas*, will probably have their trial trips within the next year. The following estimates for improvement of Navy-yard plants are submitted: \$25,000, Portsmouth, N. H.; \$30,000, Boston; \$100,000, New York; \$45,000, League Island; \$120,000, Norfolk; \$140,000, Mare Island. The Bureau renews its former recommendation that all new ships of the Navy should be subject to progressive speed trials, supplemented by turning trials whenever practicable, and again asks for an experimental tank.

The appointment of an Assistant Chief of Bureau, who shall have authority to act in the absence of the Chief, and an increase of pay to Chief Clerk and Chief Draftsman, are earnestly recommended. In view of the increasing demand for the services of carpenters as new ships are put in commission, it is urgently recommended that appointments be made to fill the vacancies now existing, and that the minimum number be re-established at 51, the number on the Navy Register in 1886. In conclusion the Bureau urges upon the Department the necessity of continuing the recent liberal policy of thoroughly equipping the various Navy-yards for all kinds of building and repair work, and training a force of skilful mechanics capable of doing the intricate and difficult work necessary in the construction and repair of modern ships of war.

THE report of the Secretary of the Navy includes a review of the work of the Department under his administration, necessarily repeating much that has been published before. Although this part of the report is interesting, its repetition here is hardly necessary. The Secretary's recommendations for the future we give, as follows:

"Another year of experience, of discussion and of criticism, both at home and abroad, confirms the Department in the views which it adopted in the annual report of 1889 as to the policy of construction which the Navy should pursue. The policy then advocated, which was a radical departure from any view previously presented in this country, consisted in the production of three principal types: First, the armored battle-ship of 10,000 or more tons; second, the armored cruiser of from 8,000 to 9,000 tons, and, third, the commerce protecting and destroying cruiser, of extreme speed, of 7,500 tons.

"Before the first battle-ships were undertaken the number required was fixed at 20. In the report of 1890 it was stated that such was the great power, both offensive and defensive, of the design evolved that the Department could safely modify its previous figure, and that 12 such battleships as were then in course of construction would equal in efficiency for our purpose the 20 that were previously contemplated. Four have now been authorized, and it remains to provide eight more, or 12 in all, of which eight should be stationed on the Atlantic Coast and four on the Pacific."

[Secretary Tracy deprecates the building of unarmored cruisers between 4,000 and 5,000 tons, and recommends the construction of several torpedo cruisers of 22-knot speed and 800 to 1,000 tons displacement; also of four 1,200-ton vessels for river services.]

"I would also renew the recommendation previously made for the building of torpedo boats. A supply of American torpedoes is now at hand, and the United States cannot afford to be any longer destitute of the boats specially adapted for their use. At least 30 such boats should be constructed in the immediate future.

"The problem of reorganization of the Navy is yearly becoming more pressing, and delay in action renders it more difficult of solution. It is clearly impossible to deal adequately with the subject in its reference to only one branch of the service, and I therefore recommend that it be referred to a Congressional commission, empowered to deal with the question as a whole, and that the various measures proposed for reorganization of the service or any part of it be considered by this commission. In addition I would urge the passage of legislation at this session which shall give to the Navy the benefit of the laws long applied to the Army, by which an officer may retire after 30 years' service on his own application in the discretion of the President, and shall be allowed commutation for quarters where no quarters are provided.

"Of all the changes in organization made by this administration the most important is that which relates to the employment of labor at the Navy yards.

"For the selection of workmen a board is established at each yard composed of the captain of the yard and two of the officers of technical departments, who act as a board of registration to classify all workmen who apply in their several trades and register them for certification to departments requiring workmen. Upon the receipt of requisitions from a department requiring men the Board is required to furnish them in the order in which they stand on the register—that is to say, in the order of their application.

"Under these rules the Navy yards have now been conducted for 15 months. During these 15 months occurred a Presidential campaign, the first within the memory of the present generation in which the yards have not been used as a political machine. In all departments of labor and at all the yards the question whether a man was a Republican or a Democrat has been absolutely and totally ignored. The foremen, whether new or old, are to-day in every case the foremen recommended by the Board; and the old had no advantage in the selection, for every foremanship was vacated before the selection was made. Not a workman has been taken on except in accordance with the rules; and while in former Presidential campaigns the yards have been packed with voters, in the last no increase whatever took place during the 60 days before the election, nor was a

workman employed beyond the normal number. The evidence of increased efficiency under this system is clear and unequivocal.

"The estimates for the fiscal year ending June 30, 1894, for the Navy and the Marine Corps, including those for public works and for increase of the Navy, amount to $24,471,498, being $2,713,141 less than those for the fiscal year ending June 30, 1893.

"The estimates for the running expenses of the Navy and Marine Corps for the fiscal year ending June 30, 1894, amount to $14,767,841, being $135,943 less than the estimates for the fiscal year ending June 30, 1893.

"The estimates for the increase of the Navy amount to $9,703,657 for the fiscal year ending June 30, 1894, and are $2,577,198 less than those for the fiscal year ending June 30, 1893."

PROGRESS IN FLYING MACHINES.

By O. Chanute, C.E.

(*Continued from page 565, Volume LXVI.*)

Ocular demonstration being always more satisfactory than description, those readers who have been sufficiently interested in the subject to try the experiments which have been described with paper planes (falling by gravity) may also like to see for themselves how an aeroplane behaves when motive power is applied. They can probably obtain in a shop one of the toys which have already been alluded to, under the head of "Screws to Lift and Propel," as one of the series produced in 1879 by M. *Dandrieux*, and which is shown in fig. 59.

This is a true aeroplane, the wings being fixed, and the propulsion being produced by the screw at the front, which

Fig. 59.—DANDRIEUX—1879.

represents the antennæ of the butterfly. This screw is driven by the unwinding of the rubber threads, and has practically no pitch except that produced by the yielding of the posterior edge of the gold-beater's skin, of which the vanes are composed. Its peculiar shape, giving a maximum of surface near the outer end, with a rigid anterior edge and an elastic posterior edge, is the result of a good deal of experiment, and may furnish a useful hint for those desiring to experiment upon a larger scale. The wings are also of gold-beater's skin, and instead of being stretched tightly upon the frame, the anterior margin only is made rigid, the rest of the surface being left quite loose, so that it may undulate when under forward motion, as in the case of M. *Brearey's* device, which will presently be described. This feature in construction, which differs greatly from that which obtains in the case of birds and insects, whose wings are elastic, but do not undulate, is said to be intended to compensate for defects in workmanship and equilibrium. Upon being tested in still air within doors, the toy will be found quite erratic in flight. It will generally go up to the ceiling, and then flutter in various directions until the power is exhausted, and seldom twice pursue the same course. Out-of-doors it will rise some 20 or 30 ft., dart about, or drift with the wind, until the rubber threads are unwound, and then glide down to the ground sustained by its aeroplane alone.

As a matter of course the sustaining surfaces have to be made very large in proportion to the weight, in order to prevent injury in alighting. One of these little toys, computed by the writer, weighs 86 grains or 0.0123 lbs., and measures 50 sq. in. in aeroplane surface, or 0.3472 sq. ft.; this being in the proportion of 28 sq. ft. to the pound, or about 0.7 of that of the real butterfly, which, being much smaller, measures some 40 sq. ft. to the pound, and which in consequence is capable of but slow flight, although it is not infrequently found by aeronauts floating about in the upper air a mile or so above the earth, a fact to which further reference will be made when we come to consider the prevalence of upward trends in aerial currents.

The propulsion of a loose undulating surface was at about the same time, somewhat differently and quite inde-

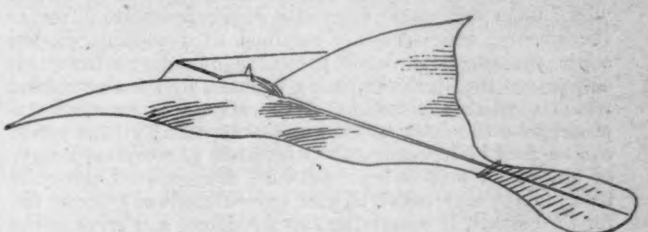


Fig. 60.—BREAREY—1879.

pendently, proposed by M. *F. W. Brearey*, the Honorary Secretary of the Aeronautical Society of Great Britain. He patented, in 1879, the apparatus shown in fig. 60, in which a flexible fabric is attached to a central spine and to vibrating wing arms at the front, which latter beat up and down like the wings of a bird. The effect of this action is to throw the fabric into a state of wavelike motions, both lengthwise and in a smaller degree also laterally, which are said to cause the apparatus to be both supported and propelled in the air, while an adjustable tail regulates the angle of incidence. The wing arms are flexible and stayed to a bowsprit by cords, and the power for an actual machine is to be placed in a car or body affixed along the central spine.

M. *Brearey* records that he took the idea from watching the movements of a "skate" fish in an aquarium, which in swimming undulated its whole body, and that he found that when applied to propulsion in air the loose fabric greatly added to the stability, so that the device might be considered as a sort of dirigible parachute, which would come down safely if the motive power became exhausted from any cause. In the various models which he made to illustrate the experimental lectures, with which he was accustomed to popularize "the problem of flight" in Great Britain, he used the torsion of india-rubber to produce the revolution of the crank which vibrated the arms, thus getting a dozen strokes or so, and he claimed that the smaller model (5 ft. × 8 ft.) flew from his hand, on one occasion at least, perfectly horizontally to the extent of 60 ft., no angle of incidence of the apparatus being perceptible. The larger model was 6 ft. wide by 10 ft. long, with about 16 sq. ft. of surface, and a weight of 3.1 lbs. (of which 0.44 lbs. was added ballast, which it easily carried), being thus in the proportion of some 5.15 sq. ft. per pound of weight, with which the falling velocity would be about 9 ft. per second, or equal to a descent from a height of 1.27 ft., but which was nevertheless found to be too heavy to be safely used in public experiments over the heads of an audience. From his experiments M. *Brearey* drew the following conclusions as to the possibilities of his apparatus:

We are thus at liberty to contemplate the construction of an aerial vehicle whose dimensions would suffice to maintain, in wave-action, 600 or 700 square feet of canvas, actuated by

steam-power, and capable of supporting the additional weight of a man, whose weight, together with the machine, would certainly not exceed 500 lbs.; and we can contemplate the man as being able to move a few feet backward or forward without much affecting the stability of the machine. His descent under the parachute action can thus be graduated at will. This can also be effected by a cord attached to the tail, which by that means can be elevated or depressed at pleasure. Placed upon wheels it has, of course, yet to be ascertained what distance of preliminary run would be required, assisted by the action of the fabric, before it would rise from the ground.

Subsequently (his second American patent is dated in 1885) M. *Brearey* further proposed the superposition of two or more sets of such "wave-action" aeroplanes, and the important addition of what he calls the "pectoral cord," which consists in an elastic cord (or suitable spring) attached to some point underneath each of the lower set of wing-arms and passing underneath the carriage, car or central spine, so that it may be thrown into tension on the up stroke, and restore the power thus stored upon the down stroke of the wing-arms. This device is designed to imitate in its action the functions of the pectoral muscle of a bird. The tension of this cord or spring is regulated in accordance with the weight to be sustained, and is said to be perfect when, upon the whole apparatus being committed free to the air, the wing-arms are retained at a suitable diedral angle against the upward pressure. It follows from this action that the up stroke, being assisted by the air pressure which sustains the weight of the apparatus, expends less power than the down stroke, and that nearly all the power can be used in depressing the wing-arms to compress a wave of air, which undulating backward and outward along the loose fabric may assist the air pressure already due to the forward speed, in sustaining the aeroplane, and serve at the same time to propel it.

M. *Brearey*, however, seems to have applied this "pectoral cord" chiefly to those of his models which showed the wing-action proper, and in the practical demonstration which he gave to the Aeronautical Society of Great Britain, at its meeting in 1882, he said :

Working in the field of experiment, I am enabled to state that the power requisite to propel and sustain a body in the air has been greatly overestimated, even by those who took the more favorable estimate in view of the ultimate attainment of flight. I am not aware, however, that the true reason for the minimum display of actual power exerted in the flight of birds has ever been propounded. Certainly it has never before been demonstrated by actual experiment.

The action of the pectoral muscles of the bird alone accounts for this. Consequently the advantage would be altogether lost in anything but a reciprocal action. The bird commits himself to the air, and the pressure of the air underneath the wings forces them upward. The weight of the bird is indicative of the pressure ; and as a consequence of this automatic raising of the wing by the pressure of the air underneath, we should imagine that the elevator muscle need not be strong. As a matter-of-fact, we find it is weak. I doubt whether any muscular effort is made to elevate the wing at all in flight ; but when not in flight, the bird of course requires the power to elevate its wing in preparation for it.

Committed, then, to the air, the elastic ligaments connected with the wings are stretched to that degree which allows of the wings being sufficiently raised for effective support without flapping, and without, as I conceive, any muscular exertion upon the part of the bird. The limited power of the elevator muscle may here come into use occasionally in aid of the under air-pressure, and with the further effect of stretching the ligaments. Now it will be argued that in the downward stroke there must be as much muscular force employed as will raise or, at least, prevent from falling, the weight of the bird ; but this is not so, because the reaction of these ligaments, which have been stretched entirely by the weight of the bird, assists materially the action of the depressor muscle. . . . .

M. *Brearey* here produced a model having wings measuring 4 ft. from tip to tip. He showed the elastic cord underneath the wings, but for the purpose of the first experiment he detached it. He then wound up the india-rubber strands 32 times, and showed that this, although sufficient to flap the wings with energy while held in the hand, was insufficient to cause the model to fly. This was demonstrated by letting the model free. He explained its inability to fly from its want of power to bring the wings down with sufficient force.

He now unwound the action and proceeded to wind it up again 32 times, and attached the pectoral cord. Holding the model in his hand, he called attention to the fact that it was powerless to flap the wings because the two forces were in equilibrium. It required the addition of another force to effect flight, and he asked what that other force could be except weight ? If now it flew, he proved beyond the possibility of doubt that weight was a necessity for flight. The model was then set free, and flight was accomplished.

He also showed that the model would only fly without the attached pectoral cord when wound up 40 times. With the cord it would fly when wound up only 13 times, thus showing the great saving in power which accrued through the action of the pectoral cord.

M. *Brearey* then produced a model of his "wave aerial machine," having 4 sq. ft. of loose surface weighted to ½ lb., and he demonstrated by its flight that the principle was equally applicable to that.

It may be questioned whether this "wave action" is likely to prove economical of power in either sustaining or propelling an aeroplane, for it seems difficult to conceive that a wave of air compressed at the front by the wing-arms should travel back to the rear, unconfined as it is either at the bottom or sides. Still, the loose surface may add to the stability, as claimed for the *Dandrieux* toy, and it would certainly diminish by its yielding the strains that would otherwise occur at the points of attachment of a rigid surface in an aeroplane ; but M. *Brearey's* wave-action seems to be chiefly applicable as a dirigible parachute, and a small model upon this principle, but without motive power, was once liberated as an experiment by Captain *Templer*, from a balloon which had risen 200 ft. or 300 ft. from Woolwich Arsenal, and it traveled back again to the arsenal, half a mile, against the wind.

It seems somewhat singular that so few efforts have been made to devise dirigible parachutes, a system which M. *de la Landelle* constantly extolled, as constituting the first requisite step toward eventual flight by working out the problem of absolute stability and safety. The only one of these devices which the writer has been able to find recorded is that of M. *Couturier*, patented in France in 1875, and this is so briefly described in the *Aéronaute* for November, 1878, that its mode of operation cannot be made out.

The "pectoral cord" attachment is probably a valuable device for flapping wings, as furnishing that inequality of effort between the up and the down stroke which undoubtedly obtains in bird flight. This effect was produced in a "wave-action" model exhibited by M. *Brearey* at the aeronautical exhibition of the Aeronautical Society of Great Britain of 1885, by a "trunk engine" designed and built by M. *Hollands*, which, however, was not shown under steam, as the boiler was only just completed in time for the exhibition ; but M. *Hollands* said that the model flew well, and supported weights, when the engine was supplied with compressed air through an india-rubber tube. He does not seem to have stated what power was exerted.

While almost all inventors and experimenters of aeroplanes have proposed some sort of motive power, and have found their designs paralyzed very soon by the want of a sufficiently light motor, there have been at various times, as already intimated, keen observers of the flight of soaring birds, who have held that once under way in a sufficient breeze, the performance involves no muscular movement whatever, save in balancing, and that the wind alone furnishes sufficient motive power (if blowing from 10 to 30 miles per hour) to enable man to soar and to translate himself at will in any direction, even (paradoxical as it may seem) against the wind itself.

Chief among these observers in recent days stands M. *Mouillard*, of Cairo, Egypt, who has spent over 30 years in watching birds soar in tropical latitudes, and who published, in 1881, a very remarkable book (in French), "L'Empire de l'air," which should be read by all those seriously interested in the solution of the problem of flight. This book, the result, as the author explains, of a passionate vocation which began at the age of 15, is almost wholly a record of personal observations and deductions. Its subtitle designates it as an "essay upon ornithology as relating to flight," but it is far more than that, for it not only de-

scribes the flight and manœuvres of birds, and gives good reasons for the author's belief that they can be imitated by man, but it describes four attempts which he has made to do so with various forms of apparatus.

M. *Mouillard* underrates, perhaps, the value of mathematical investigation, and he sometimes errs in his explanation of physical phenomena; but his observations are unrivaled, and they are presented with a particularity of circumstance, a vivacity and a charm which photograph them at once on the mind of the reader. He begins by explaining the difference between useful and unfruitful observations of creatures so willful, so swift, and so shy as the birds; then he describes the various modes of flight (both rowing and sailing), and the movements of the various organs, such as the wings and the tail; the influence of their shape in determining the mode of progression and the speed of the various species, and he shows conclusively that if these organs are properly shaped therefor, the heavier the bird the more perfectly he soars, and can, once initial speed is gained, *sail indefinitely upon the wind without further flapping his wings.* This is the keynote of the book; observation after observation is described, anecdote after anecdote is related, to impress upon the reader that there need be no flapping whatever, if only the wind be strong enough; and that when there is no wind, the soaring bird must come down to the ground or resort to flapping, like the rowing birds.

Then the effect of the speed of the wind is discussed. It is shown that certain species of soaring birds with broad wings, such as the kites, the eagles, and the vultures can sail upon a wind blowing at 10 to 25 miles per hour, but must seek shelter when it increases to a gale, while the sea-birds, with long and narrow wings, such as the gulls, the frigate bird, the albatross, sport indefinitely in the tempest blowing at 50 or more miles per hour. He arrives at the conclusion that when man succeeds in imitating the manœuvres of the soaring birds, he will utilize the moderate winds, and attain to speeds of about 25 to 37 miles per hour.

M. *Mouillard* also passes in review the individual mode of flight and characteristics of the various species of birds, both the rowers and the sailers; comprising some 13 different types, and giving tables from his own measurements of weights, surfaces, dimensions, etc., which have been compiled by M. *Drzewiecki*, and have already been quoted by the writer under the head of "Wings and Parachutes;" while he finally expresses a strong opinion that the easiest type for man to imitate is the great tawny vulture of Africa (*Gyps fulvus*), which weighs some 16.50 lbs., and spreads some 11 sq. ft. of surface to the breeze.

M. *Mouillard* explains how, in his opinion, the manœuvres of this bird can be imitated, so as to obtain both a sustaining and a propelling effect from the wind, and he describes (much too briefly) the four several attempts which he had then made to demonstrate the correctness of his theory of the possible soaring flight of an aeroplane for man.

The third of these aeroplanes, as described in 1881, is shown in fig. 61. It consisted of two thin boards, properly stiffened, to which were attached ribs of "agave" wood

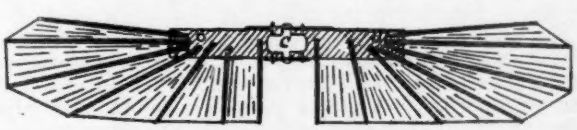


Fig. 61.—MOUILLARD—1865.

(an African aloe, exceedingly light and strong), which ribs carried the fabric constituting the two wings. The two boards were hinged vertically together (somewhat imperfectly) at the center, and the operator stood upright in the central space at *c*, suspended by four straps attached to the boards near the hinge; two of these straps passing over the shoulders and two between the legs. Moreover, light wooden rods extended from the feet to the outer ends of the boards, so that the angle of the wings with each other could be varied at pleasure.

Standing upright, with this apparatus strapped on, the hinge was about at the height of the pit of the stomach, the arms being extended out flat upon the boards, and slipping under straps; M. *Mouillard* trusting to such shifting of his body within the space *c* as he could effect by resting his weight on his arms, to produce the necessary changes in the center of gravity of the apparatus, which were required by the changes in the angles of incidence.

The whole apparatus weighed 33 lbs., but was found unduly light, as the parts yielded and the wood cracked when tested with vigorous thrusts of the legs. It had been hastily constructed, with such materials as the country afforded, and the builder was not satisfied with it.

M. *Mouillard* gives but a scanty description of his experiments with this aeroplane in "L'Empire de l'air," so little, indeed, as to suggest further inquiry; but he has since written another book, which he entitles "Le vol sans battements" (flight without flapping), which is now nearly ready for the press, and wherein he records further observations, explains more fully his ideas and the results of his meditations, giving freely, as he expresses it, "all that he knows," and in which there is a fuller account of the experiment in question.

From this forthcoming book M. *Mouillard* has kindly furnished the following extract concerning the experiment with the apparatus shown in fig. 61.

It was in my callow days, and on my farm in the plain of Mitidja, in Algeria, that I experimented with my apparatus, No. 3, the light, imperfect one, the one which I carried about like a feather.

I did not want to expose myself to possible ridicule, and I had succeeded by a series of profound combinations and pretexts in sending everybody away, so that I was left all alone on the farm. I had already tested approximately the working of my aeroplane by jumping down from the height of a few feet. I knew that it would carry my weight, but I was afraid to experiment in the wind before the home folks, and time dragged wearily with me until I knew just what the machine would do; so I finally sent everybody away—to promenade themselves in various directions—and as soon as their backs were turned, I strolled into the prairie with my apparatus upon my shoulders. I ran against the air and studied its sustaining power, for it was almost a dead calm; the wind had not yet risen, and I was waiting for it.

Near by there was a wagon road, raised some 5 ft. above the plain. It had thus been raised with the soil from ditches about 10 ft. wide, dug on either side.

Then came a little puff of wind, and it also came into my head to jump over that ditch.

I used to leap across easily without my apparatus, but I thought that I might try it armed with my aeroplane; so I took a good run across the road, and jumped at the ditch as usual.

But, oh horrors! once across the ditch my feet did not come down to earth; I was gliding on the air and making vain efforts to land, for my aeroplane had set out on a cruise. I dangled only one foot from the soil, but, do what I would, I could not reach it, and I was skimming along without the power to stop.

At last my feet touched the earth, I fell forward on my hands, broke one of the wings, and all was over; but goodness! how frightened I had been! I was saying to myself that if even a light wind gust occurred, it would toss me up 30 to 40 ft. into the air, and then surely upset me backward, so that I would fall on my back. This I knew perfectly, for I understood the defects of my machine. I was poor, and I had not been able to treat myself to a more complete aeroplane. All's well that ends well. I then measured the distance between my toe marks, and found it to be 138 ft.

Here is the *rationale* of the thing. In making my jump I acquired a speed of 11 to 14 miles per hour, and just as I crossed the ditch I must have met a puff of the rising wind. It probably was traveling some 8 to 11 miles per hour, and the two speeds added together produced enough pressure to carry my weight.

I cannot say that on this occasion I appreciated the delights of traveling in the air. I was too much alarmed, and yet never will I forget the strange sensations produced by this gliding.

Then M. *Mouillard* repaired the injured aeroplane, and he tried it again a few days later. Of this later experiment he says in "L'Empire de l'air":

I had no confidence, as I have already stated, in the strength of my aeroplane. A violent wind gust came; it picked me up; I became alarmed, did not resist and allowed myself to be upset. I had one shoulder sprained by the pressure of the

two wings, which folded up against each other like those of a butterfly when at rest.

M. *Mouillard* then determined to make no more experiments with this incomplete machine, but to build a better one, with which he could control all the manœuvres necessary for soaring, but shortly afterward his circumstances led him to leave the farm and to remove from Algeria to Cairo, Egypt. Here, in a great city, he no longer had the facilities for experimenting that he possessed on the farm, for he had to go out some distance to secure space and privacy for each experiment. Then came illness ; the former gymnast became a cripple, so that he could no longer perform for himself the acrobatic manœuvres necessary to experiment with a soaring apparatus, but still he persevered, and he describes in "L'Empire de l'air" the design for the fourth apparatus, of which he began the construction in 1878, but which was interrupted by ill-health.

Since the publication of his book in 1881, M. *Mouillard* is understood to have been continuously engaged in perfecting and simplifying his proposed soaring apparatus, and in trying experiments (by proxy) with models on a small scale. He says that he will soon be prepared to have the matter tested on a large scale, and that he has never wavered from absolute conviction in the truth of the principles which he laid down in "L'Empire de l'air," in which he expresses himself as follows :

I hold that in the flight of the soaring birds (the vultures, the eagles, and other birds which fly without flapping) *ascension is produced by the skillful use of the force of the wind, and the steering, in any direction, is the result of skillful manœuvres ; so that by a moderate wind a man can, with an aeroplane, unprovided with any motor whatever, rise up into the air and direct himself at will, even against the wind itself.*

*Man therefore can, with a rigid surface and a properly designed apparatus, repeat the exercises performed by the soaring birds in ascension and steering, and will need to expend no force whatever, save to perform the manœuvres required for steering.**

The exact shape of these aeroplanes need not be discussed in this chapter, for it will be seen further on that there are scores of shapes and devices which can be employed, but all forms of apparatus, however dissimilar, must be based upon this idea, which I repeat :

Ascension is the result of the skillful use of the power of the wind, and no other force is required.

M. *Mouillard* then continues :

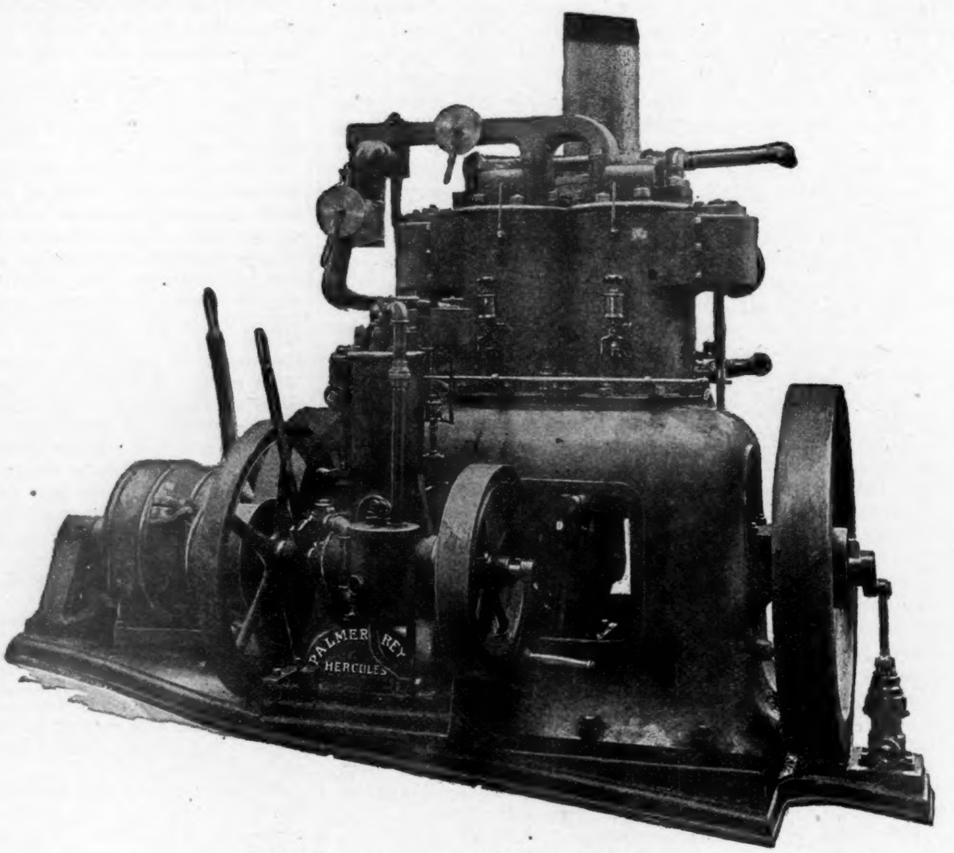
It will doubtless be very difficult for many persons to admit that a bird can, with a moderate wind, remain a whole day in the air with no expenditure of power. They will endeavor to suppose some undetermined pressures or some unseen flappings. In point of fact, the human understanding does not readily admit the above truth ; it is astonished, and seeks for all the evasions it can find. All those who have not *seen* say, when ascension without expenditure of force is mentioned to them, "Oh, well, there were some motions which escaped your observation."

It even occurs sometimes that a chance or superficial observer, who has had the luck to see this manœuvre well performed by a bird, when he turns it over in his mind afterward feels a doubt invading his understanding ; the performance seems so astonishing, so much against ordinary experience, that the man asks himself *whether his eyes did not deceive him.* For this observation, in order to carry absolute conviction, must bear upon the performance of the largest vultures, and they alone ; and this is the reason : it is because all the other birds which ascend into the air by this process do not perform the necessary decomposition of forces required in all its naked simplicity.* . . .

To be convinced, a man must *see ;* for to see the performance even once is better than a whole volume of explanations. Therefore, O reader, if you are interested in this subject, go and see for yourself, and be edified. Go to the regions where dwell the birds which perform these demonstrations ; and when you have beheld them for a few instants, being already initiated as to what to observe, comprehension will at once come into your understanding.

Whoever has seen a boy's kite ascend into the air, and considered that the string may be replaced by a weight, *if only the equilibrium be secured and maintained,* will have no difficulty in granting the correctness of M. *Mouillard's* assertion that the power of the wind is quite sufficient to secure ascension, but it will not so readily be understood how it is also sufficient to secure progression even against the wind. It will, indeed, be conceived that an aeroplane possessed of initial velocity can soar in a circle in the wind like a bird, and by changing its angle of incidence, descend somewhat when going with the wind, and rise again in consequence of the greater "lift" when facing the wind, thus gaining in height at every lap, and eventually utilizing the elevation thus gained in gliding in any desired direction, *always provided that the equilibrium be maintained ;* but this involves very delicate manœuvres, which will be further considered when we come to sum up the results of all the experiments with soaring devices, and indeed the subject warrants a paper by itself, which may be placed in an appendix.

It may, however, be said here that the French aviators, after having long doubted the reality of the performance of sailing flight by the birds, whose evolutions they were unable to watch in their climate, have had so many corroborations furnished to them by trustworthy witnesses, that they



ENGINES OF THE "HIRAM BINGHAM."

* The italics are M. *Mouillard's* own.

* The present writer has seen the feat performed by gulls many times.

now generally admit that a soaring bird can sustain himself indefinitely on a wind, without flapping, and that man may learn to imitate him if only a proper apparatus be designed, and the operator possesses the necessary knowledge and skill to work it, so as to perform the right manœuvres and at the right time.

(TO BE CONTINUED.)

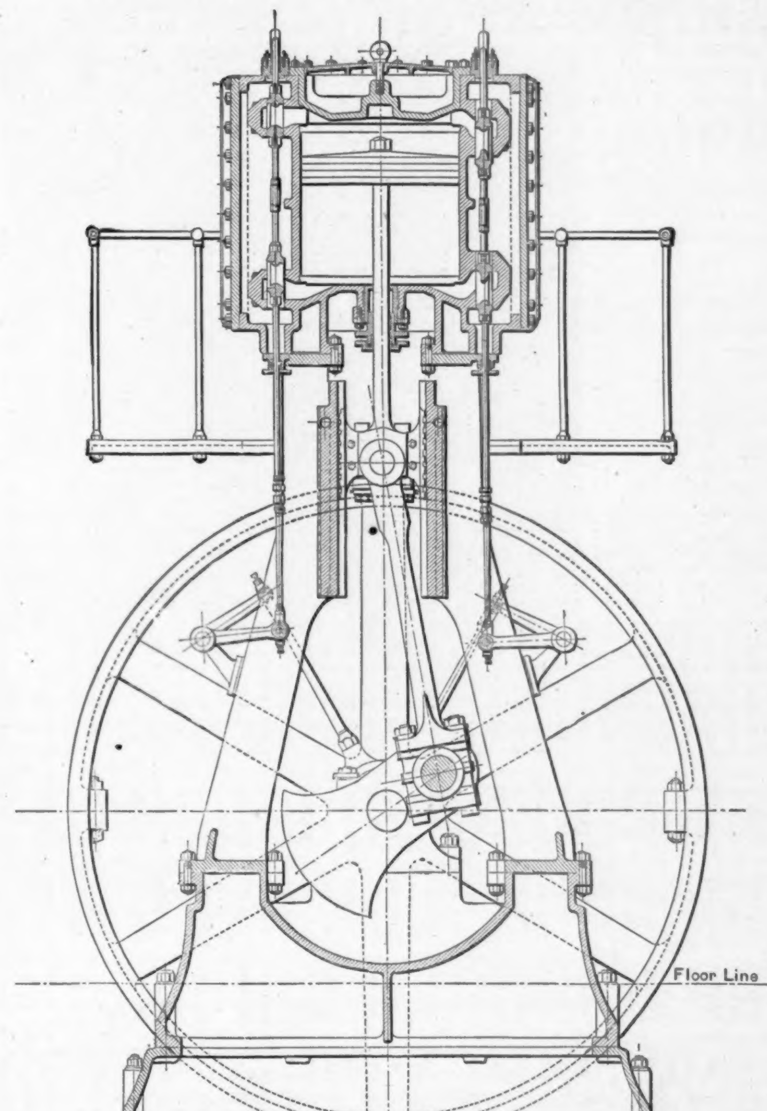
A SHIP WITH GASOLINE ENGINES.

(From *Industry*, San Francisco.)

THE *Hiram Bingham*, a vessel 50 ft. long, 14 ft. beam, fitted with full schooner rig, and also with gasoline engines of 25 H.P., by Messrs. Palmer & Rey, of San Francisco, sailed October 31 for the Gilbert Islands, *viâ* Honolulu. We were out on one of the trial trips of this strange vessel, and must confess to a modification of some previous views respecting propulsion by engines of the kind for boats of this size. Their performance was admirable, driving the schooner at 10 miles an hour without the least hitch of any kind, and running with a steadiness that could not be exceeded by a steam-engine. As may be seen from the plate above, made from a photograph of the *Bingham's* engines, the proportions, and all their connected gearing, is much heavier and stronger than is employed for stationary work, and so made in view of use in a distant land where there are no facilities for repairing, and not much for maintenance and care.

The engines were tested by Chief Engineer Kontz, U. S. N., at the works of Messrs. Palmer & Rey, and gave out over 31 H.P., or 24 per cent. more than the power contracted for. They were managed on the trial trips by Rev. Mr. Walkup, who is to take the vessel out to the Gilbert Islands, where he will employ her for missionary purposes.

It is a most remarkable adventure in several ways. Rev. Mr. Walkup has a scientific turn, and holds his certificate as a navigator, but to start across thousands of miles of wide ocean in a craft of this size with a crew of three persons—a Swedish mate and two natives of the Gilbert Islands—seems a remarkable venture, which we hope will turn out successful. At sea the sails alone will be used, unless in the case of a calm, the screw being disengaged so it will revolve free. There is fuel enough provided for emergencies, and a fresh supply will be taken in at Honolulu, if the vessel gets there.



VERTICAL COMPOUND ENGINE, BY THE LAKE ERIE ENGINEERING WORKS.

A NEW VERTICAL COMPOUND ENGINE.

ON account of the extremely severe service of engines for driving generators supplying current for electric railroads, lighting and power plants, the ordinary commercial engine heretofore used has been found inadequate to meet the demands of this service as regards regulation and sudden changes of load. Builders furnishing engines for this service have found it necessary to change their old designs in such a way as to make practically new designs, in order to meet these requirements.

A new type of engine, designed especially for this class of work, has been recently brought out by the Lake Erie Engineering Works of Buffalo, of which company the Field Engineering Company are the Eastern representatives. Illustrations of their standard design will be found herewith, the engravings showing a 500-H.P. vertical compound engine, having two cranks at 90° and with belted wheels. The design, however, is extremely flexible as regards the arrangement of wheels and cylinders for compound or triple expansion, either for belted work or direct connection to multipolar generators. The smaller cut is a general view of the engine, and the larger one is a section through the center.

The cast-iron columns are of the double-box girder type of A frame, securely bolted to the lower part of the cylinder and to the main pedestals, carrying brackets for valve rockers, and having the guides bolted to their inner faces. These guides are easily removed and renewed in case of accident. Each cylinder frame consists of two double columns secured to a main pedestal at the lower extremities and supporting the cylinder bolted to their upper ends. This main pedestal carries at each side a main bearing which is removable, and between these bearings the cranks are situated. A cylinder, its columns and main pedestal compose a unit. These units do not differ materially in the three cylinders of a triple or the four cylinders of a quadruple, except in the diameter of cylinders for their respective positions in the sequence of expansion. These units are placed on a common bedplate, extending to a sufficient distance below the shaft to allow the wheels or generators to be placed in any desired locality along the crank shaft. This bedplate is practically a sub-

LOCOMOTIVE RETURNS FOR THE MONTH OF SEPTEMBER, 1892.

Name of Road.	Number of Serviceable Locomotives on Road.	Number of Locomotives Actually in Service.	Locomotive Mileage.					Av. Train.		Coal Burned per Mile.						Cost per Locomotive Mile.							Cost per Car Mile.		Cost of Coal per Ton.
			Passenger Trains.	Freight Trains.	Service and Switching.	Total.	Average per Engine.	Passenger Cars.	Freight Cars.	Passenger Train Mile.	Freight Train Mile.	Service and Switching Mile.	Train Mile, all Service.	Passenger Car Mile.	Freight Car Mile.	Repairs.	Fuel.	Oil, Tallow and Waste.	Other Accounts.	Engineers and Firemen.	Wiping, etc.	Total.	Passenger.	Freight.	
										Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	C s.	$
Alabama Great Southern	...	55	38,949	77,748	37,708	154.405	2,807	....	....	62.30	84.39	51.54	69.44	...	...	4.30	4.30	0.31	0.50	6.20	2.00	17.61	....	....	....
Alabama & Vicksburg	....	17	18,370	14,041	11,252	48,663	2 569	....	....	45.87	83.33	41.67	58.31	....	....	3.20	4.90	0.27	0 70	6.20	1.80	19.07	....	....	....
Atchison, Topeka & Santa Fé	834	738	....	....	434,719	2,309,909	3,130	....	....	...	....	...	81.20	....	....	4.73	6.50	0.28	0.12	6.59	1.40	19.64	....	. ..	1.54
Canadian Pacific	599	....	490,678	751,220	466,983	1,708,831	2,853	. ..	....	....	....	...	62.44	....	...	10.50	3.48	0.41	....	5 24	1.31	20.94	....	1.81	3.32
Chic., Burlington & Kansas City	12	11	13,510	27,771	....	41,281	3,753	3.03	12.80	....	....	....	81.53	21.21	10.08	6.34	5.48	0.21	0.26	6.05	....	18.34	....	...	1.36
Chic., Burlington & Quincy	525	....	....	....	....	1,919,799	3 657	5.21	19.63	...	....	....	82.71	....	.	4.18	5.38	0.24	0.17	6.66	....	16.63	....	....	1.31
Chic., Milwaukee & St. Paul	808	..	....	....	....	2,872,720	3,555	....	....	....	...	....	67.77	...	....	3 45	6.94	0.27	...	6.78	....	17.44	....	....	2.00
Chic., Rock Island & Pacific	553	....	612,516	1,050,465	420,262	2,083,243	3,767	....	.. .	54 45	76.04	39.72	62.00	....	. ..	2.73	5.75	0.23	....	5.98	0.39	15.08	....	....	1.60
Chicago & Northwestern	871	....	687,472	1,469,725	815,118	2,972,315	3,413	....	...	....	....	....	80.47	...	....	3.22	7.30	0.35	....	6.32	0.78	17.97	.. .	....	1.80
Cincinnati Southern	....	97	84,826	164,027	82,353	331,206	3,415	....	....	60.81	112 36	36.90	81.63	.. .	....	4.40	4.70	0.28	1.30	6.50	1.80	18.98	....	....	....
Cumberland & Penn.*	23	21	5,372	34,001	....	39,373	1,875	....	....	....	....	....	84.38	....	....	9.00	4.60	0.50	....	...	1.80	15.90	....	....	.. .
Delaware, Lackawanna & W. Main L.	208	197	....	....	....	683,449	3,769	....	....	....	....	....	79.36	....	....	3.31	6.19	0.38	...	5.86	....	15.74	....	....	....
Morris & Essex Division	159	....	166,519	224,590	13,182	404,691	2,543	....	....	.. .	....	....	60.88	....	....	4.22	9.50	0.42	....	6.42	...	20.56	....	....	3.11
Hannibal & St. Joseph	....	66	75 176	172,531	37,490	285,197	4,321	5.46	17.39	....	....	....	83.65	13.00	6.04	6.66	5.52	0.19	0.12	6.45	....	18.94	....	....	1.34
Kansas City, F. S. & Memphis	144	....	97,860	237,474	125,180	460,514	3,198	....	....	....	....	....	57.72	....	...	3.82	4.77	0.32	0.35	7.36	....	16.62	....	....	1.61
Kan. City, Mem. & Birm	41	38	35,447	56,914	15,868	108,229	2,848	....	....	....	....	....	62.12	....	....	3.29	3.43	0.24	0.36	7.02	....	14.34	....	....	1.06
Kan. City, St. Jo. & Council Bluffs	....	42	59,435	49,856	49,445	158,736	3,779	5.11	22.50	...	....	....	64.79	14.09	4.18	3.05	5.55	0.11	0.30	5 87	....	14.88	....	....	1.86
Lake Shore & Mich. Southern	592	575	430,477	769,072	641,294	1,840,843	3,184	....	....	60.88	83.61	31.28	60.89	....	....	2.73	4.65	0.17	....	6.94	0.18	14.67	....	....	1.52
Louisville & Nashville	....	†344	439,633	796,734	393,018	1,639,385	3,594	5.15	16.12	63.52	105.49	46.29	78.87	12.39	6.32	4.10	6.42	0.26	0.48	6.10	1.51	18.87	3.26	1.43	1.63
Manhattan Elevated	....	275	732,614	....	50,594	783,208	2,848	....	....	....	....	....	40.82	....	....	2.10	8.10	0 30	....	8.80	....	19.30	....	....	3.96
Mexican Central‡	....	...	....	....	....	....	....	....	.. .	...	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Mil, L. S. & Western	112	....	80,381	167,945	114,690	363,016	3,241	....	....	....	....	....	69.37	....	....	.77	9.52	0.25	...	6.14	0.88	19.56	....	....	2.75
Minn., St. P. & Sault Ste. Marie	....	....	62,729	136,579	65,821	265,129	...	4.94	19.41	...	....	....	65.14	....	....	3.44	10.89	0.20	....	6.41	....	20.94	..	1.67	3.33
Missouri Pacific	339	311	....	....	....	1,211,122	3,894	4.52	18.29	....	....	....	84.64	14.43	6.04	4.95	6.12	0.36	1.32	6.64	1.32	20 71	4.71	1.26	1.42
N. O. & Northeastern	....	33	30,676	44,228	24,465	99,369	3,011	....	....	64.52	100.00	34.01	73.26	....	....	5.60	6.20	0.32	0.50	6.30	1.70	20.62	....	...	....
N. Y., Lake Erie & Western	....	621	464,466	993,637	301,004	1,759,107	2,832	4.80	23.40	87.60	122.70	65.60	....	18.20	5.30	4.44	6 93	0.40	2.29	7.20	1.06	22.32	....	1.54	1.34
N. Y., Pennsylvania & Ohio	....	255	135,104	435,336	136,121	706,561	2,771	5.90	18.30	76.40	126.20	71.30	....	13.00	6.90	4.68	6.07	0.30	2.46	6.91	1.01	21.43	....	1.73	1.15
Norfolk & Western, Gen. East. Div.*	....	145	100,854	271,296	55,126	427,276	2,947	4.80	19.90	....	...	....	96.62	....	....	7.30	3.10	0.70	....	....	....	11.10	....	....	....
General Western Division*	....	118	64,876	235,016	27,800	327,692	2,777	4.70	15.70	...	....	....	120.48	....	....	14.70	3.60	0 70	....	....	....	19.00	...	....	...
Ohio & Mississippi	119	....	148,312	149,151	93,168	390,631	3,283	. ..	....	....	....	....	69.68	...	....	2.85	3.09	0.22	1.30	5.42	1.31	14 19	....	....	0.86
Old Colony	....	227	366,001	128,749	124,666	619,416	2,729	....	....	....	....	....	58.22	....	....	3.19	10.92	0.63	....	6.55	0.75	22.04	....	....	3.75
Philadelphia & Reading	....	....	492,532	767,772	554,033	1,804,237	....	....	....	....	....	....	75.41	....	....	4.48	4.53	0.33	....	5.82	0 40	15.56	....	....	....
Southern Pacific, Pacific System	....	....	....	.. ....	....	....	....	....	....	....	...	....	....	....	. ..	....	....	....	....	.	....	....	....	...	....
Union Pacific	994	....	821,298	1,492,916	507,443	2,821,657	2,829	5.81	17.38	....	.. .	. ..	87.14	12.74	6.87	6.93	8.00	0.43	0.74	7.93	1.03	25.06	4.05	1.82	1.83
Vicksburg, S. & P.	....	14	10,858	10,488	9,576	30,922	2,209	....	....	46.84	79.36	28.49	53.05	...	....	6.60	5.90	0.22	1.20	6.70	3.00	23 62	....	....	....
Wabash	406	357	413,442	799,885	372,261	1,585,588	4,199	5.19	18.02	69.23	104.99	55.34	84.00	13.34	5.83	3.23	4.71	0.29	....	6.39	0.77	15.39	2.64	0.97	1.12
Wisconsin Central	149	130	129,253	257,784	95,726	482,763	3,724	....	....	....	....	....	76.77	....	....	3.54	9.31	0.29	....	6.97	....	20.11	....	....	2.38
Year Ending September 30.																									
N. Y., Lake Erie & Western	....	618	5,375,133	12,092,424	3,598,133	21,065,690	34,087	4.70	21.70	87.80	127.70	68 50	....	18.80	5.90	4.82	6.09	0.41	2.21	7.17	1.10	21.80	....	1.60	1.33
N. Y. Pennsylvania & Ohio	. .	261	1,701.366	5,263,202	1,692,072	8,656,640	33,167	5.40	17.90	75.70	124.70	70.30	....	14.00	7.00	4.36	6.34	0.31	2.34	6.72	1.02	21.09	....	1.77	1.20

NOTE.—In giving average mileage, coal burned per mile and cost per mile for freight cars, all calculations are made on the basis of *loaded* cars.

* Wages of engineers and firemen not included in cost.

† Number of engines in revenue service only; average mileage is also based on revenue service.

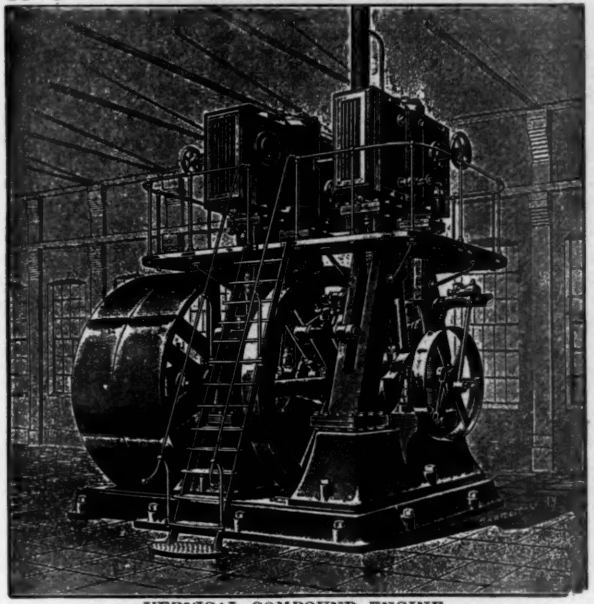
‡ The Mexican Central Railroad reports —— units of work per $1 of expense; —— units of work per ton of coal; —— lbs. of coal per unit of work. The unit of work is 100 gross tons hauled one mile in one hour on a straight and level track.

structure of iron, to which direct coupled generators may be firmly secured.

The piston speed is kept uniform in all sizes of engines, being 650 ft. per minute, the rotative speed varying from 80 revolutions on a 2,000 H.P. triple to 246 revolutions per minute on a 100-H.P. compound, thus allowing the engine to be connected direct to generators.

The cylinders are of the four-valve type, having two ports for steam and two ports for exhaust, with a steam-chest on one side and an exhaust-chest diametrically opposite on the other side, standing at right angles with the crank-shaft, and allowing perfect freedom of access. The clearances are from 2½ to 7 or 8 per cent., according to the diameter of the piston, being least on the greater diameters, and modified somewhat by the pressures of steam, higher pressures requiring larger port areas and larger clearances.

The cylinders are substantially and neatly lagged with iron, and the intervening spaces between the cylinders and lagging filled with non-conducting material. The steam-chest covers are provided with hoods, paneled and polished on the exterior surface. The valves are small, light and four ported, the high-pressure steam valve being perfectly balanced and the others working under light pressures on their seats. The steam and exhaust valves are worked by independent gear and the lap is adjustable, permitting of the most advantageous setting for either condensing or non-condensing service. The governor and steam valves are constructed to carry the steam as far as seven-eighths stroke in the first cylinders should the demands of the load at any time require it, permitting the engine to exert not less than 30 per cent. more power than any engine with releasing valve gear of same diameter of cylinders and piston speed. This feature specially qualifies the engine for railroad and other work requiring high powers through short periods of time.



VERTICAL COMPOUND ENGINE.

In most marine engines using piston valves in the high-pressure cylinder, the diameter of the valve-chest is often as large, if not larger, than that of the high-pressure cylinder itself. In a triple-expansion engine, and with the same style of valve used on the low pressure, it becomes necessary to use two and sometimes three different valves, having their centers on a circle whose center is coincident with that of the low-pressure cylinder.

The movement of the high-pressure admission valve is controlled in these engines by the centrifugal shaft governor, by which means the engine is regulated as regards speed of revolution. This point is of course a very important one in this class of work, and in this governor, which has only one weight, one spring and four pivoted joints, the sensitiveness is very great, as is shown by the variation of speed of the engine in regular work, which does not exceed 1 per cent. under extreme changes of load, and is not over 2½ per cent. when two-thirds of the rated load of the engine is thrown off or on. Some objections have been raised to the advisability of governing an engine of large powers—say 500 H.P. and upward—by means of a shaft governor. The fact that these engines are running to-day successfully on this class of work and under the above regulation meets this argument conclusively.

The makers have given much care to the details of construction. For instance, the piston-rod and cross-head are forged in one piece, and babbitted slippers fastened to the head of the rod, set out, not by wedges, but by liners only. The connecting rod is forged and of the forked pattern, having the wrist-pin secured firmly in the ends of the fork, and a central bearing in the cross-head. The crank end has a two-part box independent of the rod forging, with through bolts.

Another very important consideration, and too often overlooked, is that of main bearings. The pressure per square inch of projected area and the surface velocities are often so near the limit that, when any slight overload comes on the engine, heating occurs immediately. Special attention has been given to this point, and the main bearings are so proportioned that the pressures and the velocity of the rubbing surfaces are uniform in all engines, whether the engines be simple, compound, triple or quadruple, and the service is within the limits of remarkable durability and ease of management; bearings being supplied with appliances for grease or oil lubrication as desired. All wearing surfaces on the larger size engines are water-jacketed.

As regards the economy, it can be readily seen from the steam distribution effected by means of the valve gear described on this engine, that the economy shown should be equal to that of a Corliss. The cylinder condensation is low, the clearances are small and the steam distribution through the cylinders is nearly perfect. The engines are built in all types and sizes, in simple, compounds, triples and quadruple expansion, up to 8,000 H.P. units. No expense has been spared to make this engine fit the exact requirements of the service, and this is the first engine, probably, that has ever been designed under these conditions for general commercial sale.

Further information can be obtained from the Field Engineering Company, 143 Liberty Street, New York.

Foreign Naval Notes.

THE armored coast-defense ship *La Libertad*, just completed by Laird Brothers at Birkenhead, England, for the Argentine Navy, has had her speed trials, making an average speed of 13.35 knots with natural draft and 14.32 knots with forced draft. *La Libertad* is a twin-screw steel ship 240 ft. long, 44.4 ft. beam, 13 ft. draft and 2,300 tons displacement. She has a water-line armor belt, a heavy protective deck, two armored barbettes and a central breastwork. Each screw is driven by a triple-expansion engine with cylinders 21 in., 31½ in. and 46 in. × 24 in.; on the trial they worked up to 2,900 H.P., with 145 lbs. steam pressure. The armament includes two 9.5-in. Krupp guns; four 4.7-in. Armstrong rapid-fire guns; four 3-pdr. Maxim guns and four machine guns; there are also four torpedo-tubes.

THE new Russian cruiser *Rurik* was successfully launched from the yard of the Baltic Shipbuilding & Machine Works, at St. Petersburg, November 3, with appropriate ceremonies, the Imperial Family and a large number of officers and invited guests being present. The *Rurik* is a first-class cruiser, the largest yet built in Russia; her construction was begun in August, 1890, and the engines are not yet quite ready. The general dimensions are: Length, 435 ft; breadth, 67 ft.; mean draft, 25 ft. 9 in.; displacement, 10,933 tons.

The hull was built by the Baltic Works, the steel being furnished by the Putiloff Works of St. Petersburg, and the armor-plates by the Naval Works at Izhora, near St. Petersburg. The hull is sheathed up to the water-line with double planking covered with copper. In building the hull there were used 3,060 tons of steel and 28 tons of copper, besides 100 tons of bronze for the rudder, the shaft bearings, stem and stern castings and such work. The wood used in construction was fir for the inner layer of hull sheathing and for deck planking; larch for the outer layer of sheathing and for backing for the armor plates.

The *Rurik* will have four triple-expansion engines, two to each screw. They are now under construction at the Baltic Works, and are expected to develop 12,250 H.P. The coal

storage capacity will be sufficient to carry the ship from St. Petersburg to Vladivostok without calling at any port.

The armament will consist of four long-range 8-in. guns; sixteen 6-in. rapid-fire guns of the latest pattern; six 4.7-in. rapid-fire guns; sixteen 47-mm. and 37-mm. rapid-fire guns; two Baranovski machine guns; and six torpedo-tubes.

Next year the building of a still larger cruiser will be begun.

Manufactures.

A Modern Boiler Plant.

THE illustrations given below show a steam plant designed and constructed for Curtis Davis & Company, Cambridgeport, Mass., by Westinghouse, Church, Kerr & Company, of Boston; the detail work being carried out by William R. Roney, the Engineer of their stoker department. *Carte blanche* was given the engineers to design a boiler house to contain every practical element of economy which could bear upon the sum total of the cost of making steam; they being limited only to the horizontal return-tubular type of boiler by certain considerations outside of economy.

In the carrying out of this work the ornamental side of the problem was not forgotten, and the architectural design of the boiler house was prepared by Hartwell & Richardson, of Boston. It is worthy of emphasis that the owners of this plant have set a creditable example to manufacturers in general in providing a building which shall not only be adapted to the matter-of-fact work to be done in it, but shall present a fitting and dignified appearance. The building is of pressed brick with trimmings of pink Milford granite. The roof is of iron trusses, covered with slate and lined on the inside with wire lath and plaster, for the purpose of preventing condensation. The fire-room floor is of concrete. An annex to the building contains a scale-room for tallying the weight of coal, and a complete wash-room for the fireman, who has now become a gentleman of leisure.

Passing to the operative portion of the plant, it will, when completed, consist of eight horizontal return-tubular boilers of 125 nominal H.P. each, to carry a working pressure of 130 lbs. These boilers are arranged in two batteries of four each in either end of the building (one battery is now in operation), the space between being utilized as a pump-room. Following the progress of the coal, after it is weighed it is dumped on a grating at the end of the boiler house, shown in the general view. The large lumps are easily broken by the teamster, the grating serving as a screen to reduce the coal to a uniform maximum size. From the grating the coal falls into a bucket elevator carrying it to an overhead conveyer extending the entire length of the boiler house, from which it distributes into square iron bunkers having hopper bottoms. The bunkers are supported on iron girders in front of and above the boilers. From the bunkers the coal flows by gravity through swivel spouts to the hoppers of the stokers.

Each boiler is equipped with a Roney mechanical stoker, which furnishes a continuous supply of coal to the furnace at a slow rate of feed; the quantity of coal and its distribution being regulated at will by hand-wheel adjustments on the traverse motion. The power to operate the entire battery of stokers is a small engine carried on a bracket at one end of each battery, and driving a slow-moving eccentric shaft.

Fig. 1.

SECTION THROUGH STOKER.

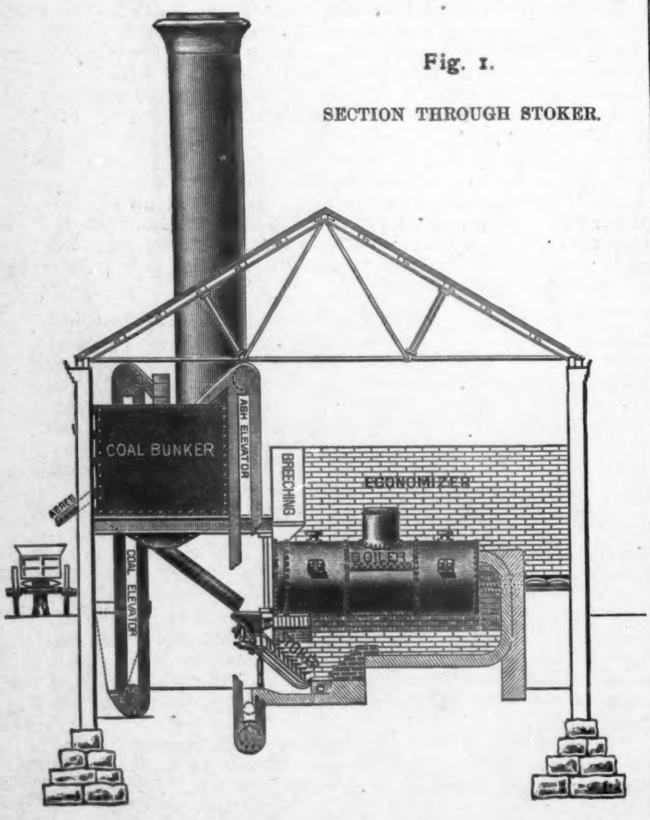
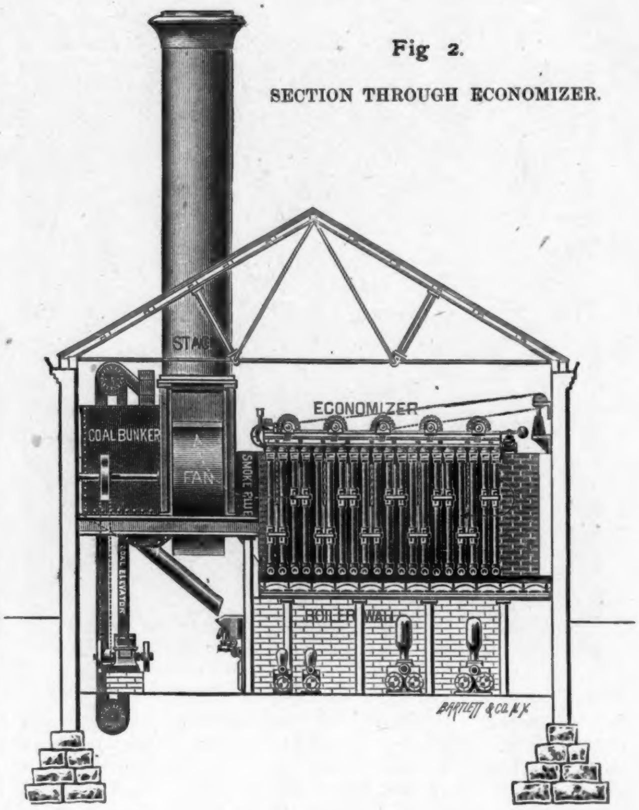


Fig 2.

SECTION THROUGH ECONOMIZER.



The action of the stoker is first to liberate the free gases and partially coke the coal on a dead plate underneath the coking arch, in connection with an indraft of hot air through perforated channels in the firebrick tile. This portion of the device constitutes a strictly smokeless furnace, the result being obtained, not by *concealing* or *consuming* the smoke, but by actually *preventing* it by complete combustion from the start. In this is a large portion of the economy due to mechanical stoking, to say nothing of the extermination of the smoke nuisance. After leaving the coking arch the coal is slowly worked down over the rocking grates into the hottest portion of the fire, and when consumed, the ash and cinder falling on the dumping grates is dropped into the ash-pit. From the ash-pit the ashes fall into a screw conveyer, which carries them to one end of the building where they are elevated into an ash-bin and discharged as required through a spout into carts for removal. Thus, from the time the coal is first dumped by the teamster until the ashes are in the cart, there is practically no manual labor employed, and the duties of the fireman reduced essentially to watchfulness and supervision only. One man constitutes the force of firemen and runs the entire plant.

A most interesting portion of the plant is the means of securing controllable draft. The usual expensive chimney stack is conspicuous by its absence, and in its place will be found a steel stack 72 in. in diameter, extending 17 ft. above the ridge of the roof and showing a total height to the top of about 55 ft. above the ground. This stack is lined with one course of brick merely to prevent rust, and is finished with ornamental top. The stack having no functions, so far as the production of draft is concerned, is only of a length sufficient to deliver

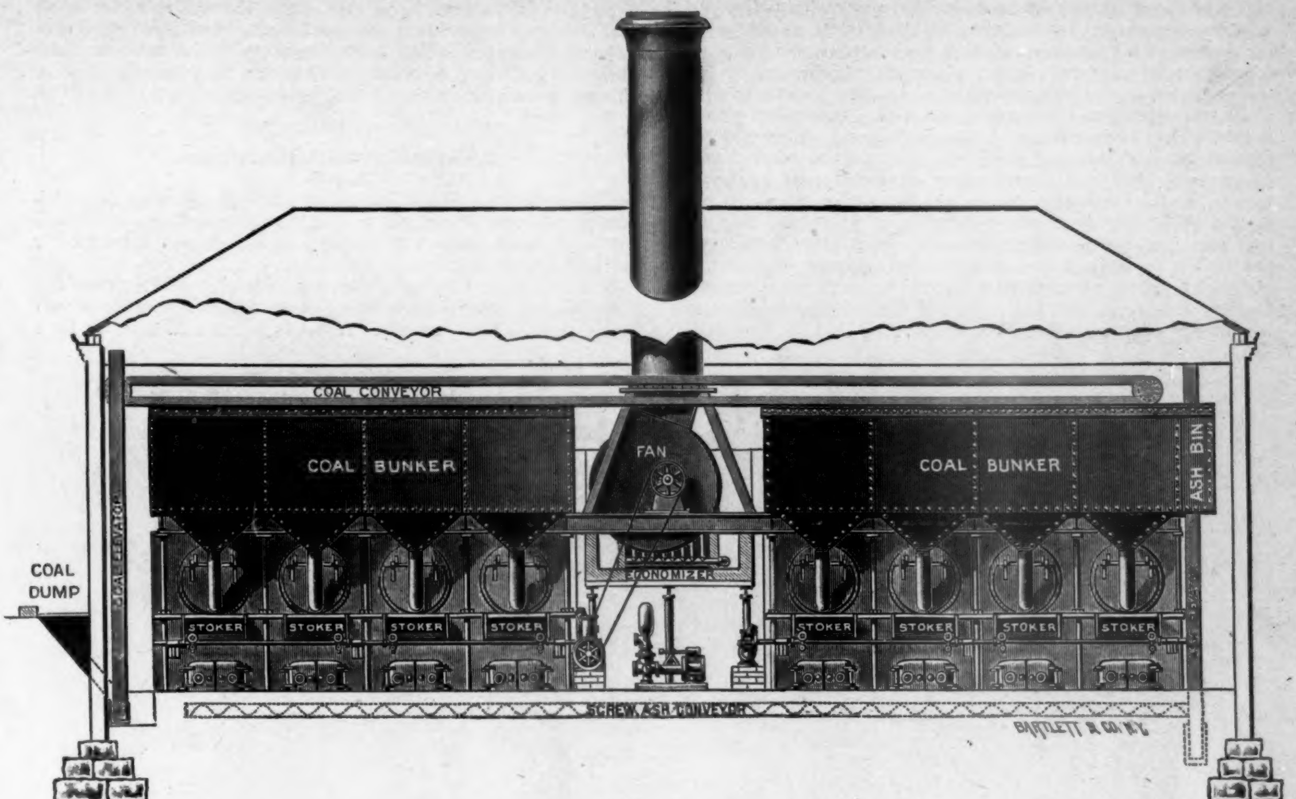


Fig. 3.

ELEVATION OF PLANT.

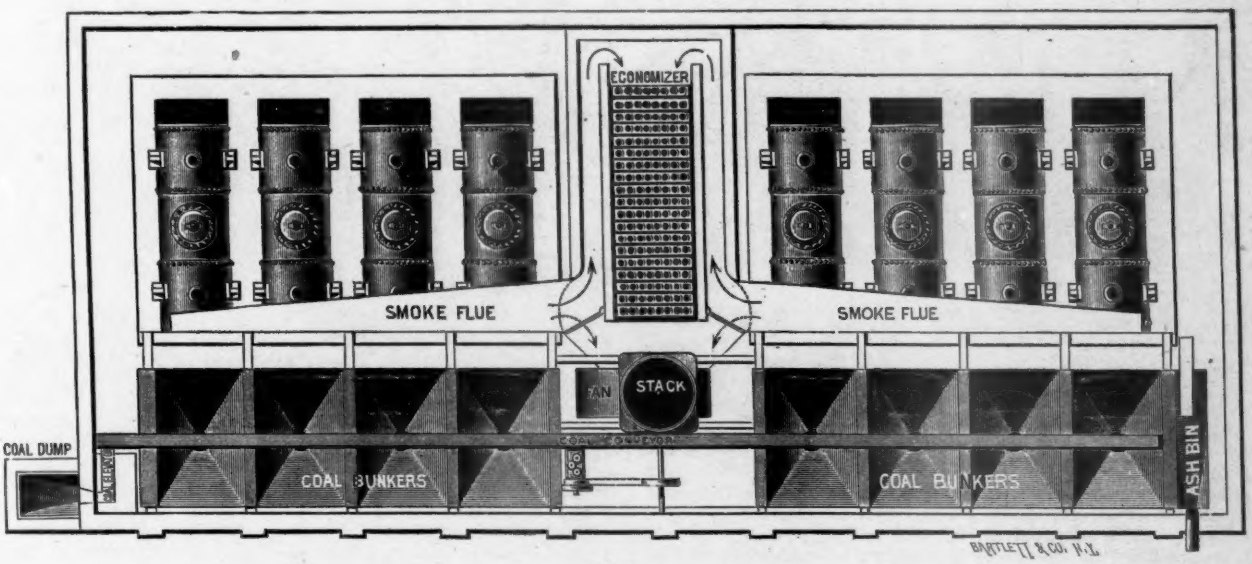


Fig. 4.

PLAN OF BOILER ROOM.

the gases above the roof. The stack is supported on an entablature, which in turn is carried on I-beams over the boiler room. On these I-beams is a large slow-running exhaust fan, whose outlet discharges directly up into the bottom of the stack. The waste gases from the furnace pass through a Lowcock economizer, which opens into the suction of the fan. The economizer is carried on iron columns, and the whole system is therefore overhead and out of the way, leaving a clear floor space below. A by-pass damper is provided on each side of the economizer, so that the draft can be direct to the stack in case the economizer is temporarily out of service for repairs. A steam-cone nozzle may be set in the base of the stack as a relay in the remote contingency of any necessity for overhauling the fan. The probability of repairs is best judged by the fact that the usual speed of the fan in ordinary service is from 40 to 50 turns per minute, and when driven at the slow speed of 80 turns per minute it is sufficient to cause a draft adequate to the most intense combustion. The motive power of the fan is a small Westinghouse engine, nominally of 10 H.P., but in fact running at so slow a speed and under such a close throttle as to develop only a fraction of that power. The draft is automatically controlled by a pressure regulator in the steam pipe to the engine, so that the speed of the fan is varied according to the steam pressure in the boilers, being in this respect the equivalent of the most sensitive steam damper. This scheme of mechanical draft is capable of producing a draft pressure equal to that of a 200 ft. chimney costing ten times as much to build, and additionally possesses the feature which no natural draft enjoys, of absolute flexibility in meeting sudden demands of steam. The fireman is thus rendered independent of weather conditions, and has nothing to fear from a dirty fire after a long run, or from any of the emergen-

cies which may throw an excessive duty upon his boiler plant without warning. He has the fire at all times wholly within his control, while at the same time the regular service is performed under the most perfect automatic regulation.

The action of the economizer is, of course, to extract all the available heat from the waste gases and return them into the boiler. The temperature of the up-take is about 100°, the temperature of the feed water leaving the economizer being upward of 300°, and representing an amount of heat saved which would otherwise be wasted up the stack as the only means of producing a natural draft. A moment's reflection will show the comparative value of the heat thus returned to the boiler, as against the insignificant amount of steam required to run the slow-moving fan. The mechanical exhaust draft in this case was not a part of the original scheme, but was finally adopted when it was discovered that the cost of the piling alone for a suitable chimney stack was more than the entire cost of the mechanical draft system, leaving the economical value of the economizer as a clear gain.

Incidentally the design of the hydraulic system, including the pumps and service line, was also made a part of the duty of the engineers, Westinghouse, Church, Kerr & Company. The pump-room is located, as before mentioned, between the batteries of boilers underneath the economizer, and in it are two duplex pumps of a capacity of 500 gallons per minute each. These pumps are controlled by pressure regulators, and are so connected that while one of them is furnishing the ordinary elevator service the second one is kept slowly moving, so as to be in condition for instantaneous fire service. The work of these pumps is alternated daily, and in case of fire both can be concentrated immediately on the fire lines. In the same pump-room are double boiler-feed pumps, each one adequate to the entire capacity of the plant. All the hot-water lines and fittings are of brass, and by-passes are provided so that the feed water can be pumped through the economizer, or direct to the boilers in case of repairs to the latter. A further system of a water meter with by-pass valves is so arranged that the feed water can be measured and pumped to either boiler independently, or to any number of boilers, or to the entire battery, at will. With a water meter in the feed line and a pair of scales at the gate, it is proposed that the condition of the entire plant, as to its evaporative duty, shall be daily logged and reported to the office, and any decline of efficiency thereby promptly and practically detected.

A New Horizontal Car Borer.

THE accompanying illustration shows a new multiple horizontal car borer, one of the most useful and powerful machines made for rapid and heavy boring. It is especially adapted for car and bridge work.

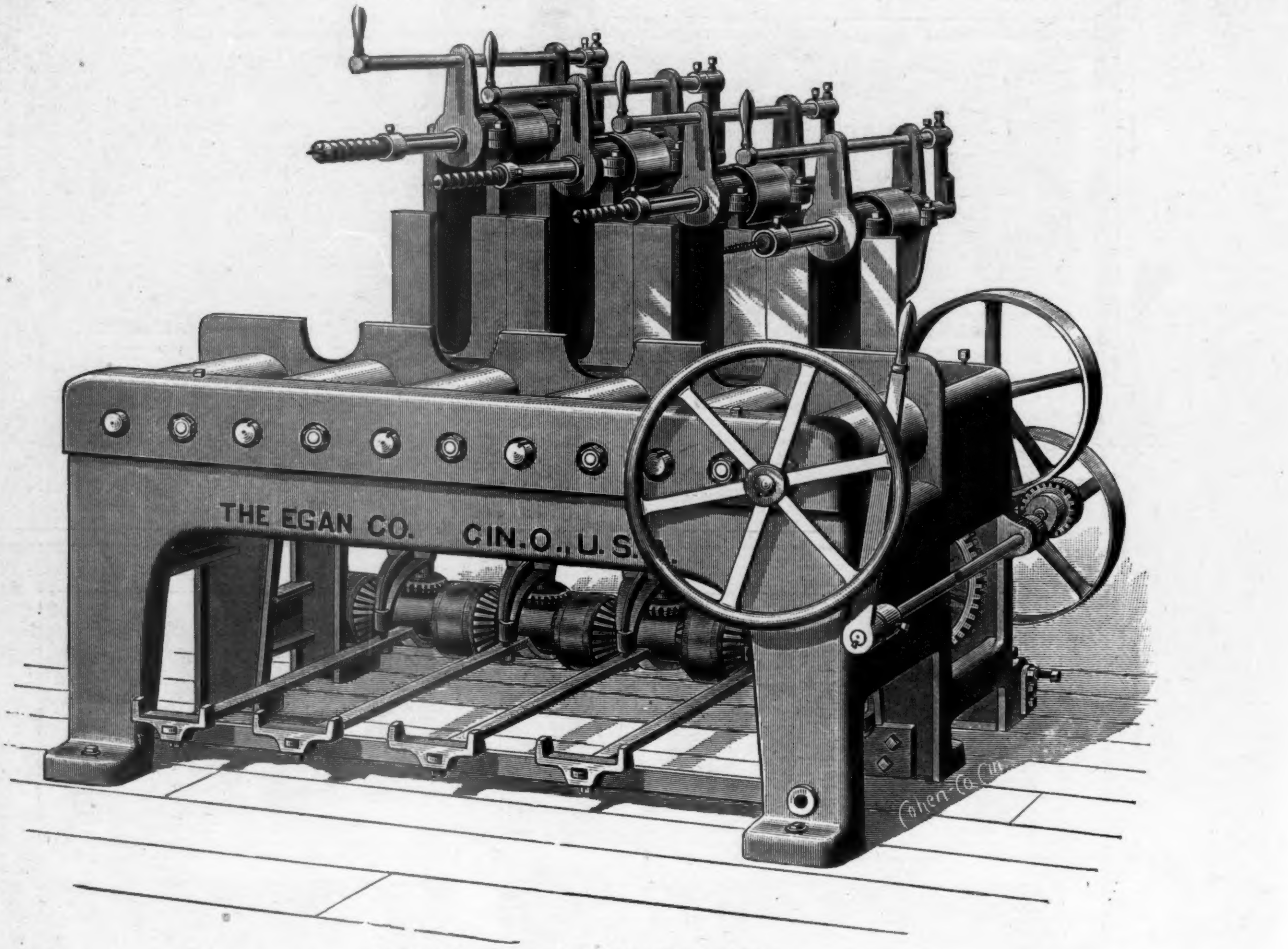
The column is one heavy casting, planed perfectly true for the mandrel frames to raise and lower in, keeping them perfectly rigid. Each mandrel frame is raised and lowered by a combination of gears and friction, operated independently by power, by means of treadle convenient to the operator.

The roller frame is of large size, extra heavy, and carries six large feed rolls driven by power in either direction, or by hand at the will of the operator.

The spindles are of steel, of large diameter, brought to the work by hand and stops provided for gauging the depth of boring. The machine is of great capacity. Holes can be bored as deep as 16 in., and each spindle can be raised 14 in. above the table.

The tight and loose pulleys are 18 in. in diameter and 5½ in. face, and should make 450 revolutions a minute.

This machine is a new one just added to the extensive list of the makers, the Egan Company, Nos. 194–214 West Front Street, Cincinnati, O.



NEW MULTIPLE HORIZONTAL CAR BORER.

Paint for Lighthouses.

THE firm of W. W. Lawrence & Company, in Pittsburgh, recently filled an order from the United States Government for nearly 10,000 galls. of paint, which is to be used on the lighthouses and Government buildings on the Atlantic Coast

from Maine to Florida. The exposure to the winds and salt air of the sea-coast is very severe on paints, and very few will stand the test. Two years since this firm filled a similar order, which indicates that its paint has fully satisfied the strict requirements of the Government service.

A New Water-Tube Boiler.

The accompanying illustrations show a new form of sectional water-tube boiler made by the New York Safety Steam-power Company, and known as the Worthington boiler. Fig. 1 shows this new boiler complete, and fig. 2 with the casing removed. It belongs to the sectional class, in which the water is contained in small tubes and chambers, designed to secure the important requisites of safety, durability, accessibility and high evaporative efficiency, and is designed to be economical of valuable space and at the same time to be of liberal proportions in grate area and heating surface. The interior of the entire construction, in every part and detail, is accessible from the outside for examination, cleaning or repair. The furnace extends under the entire boiler and is of proper height to permit the use of any kind of fuel. As will be noted, the tubes are arranged in transversely inclined series of several tubes per section.

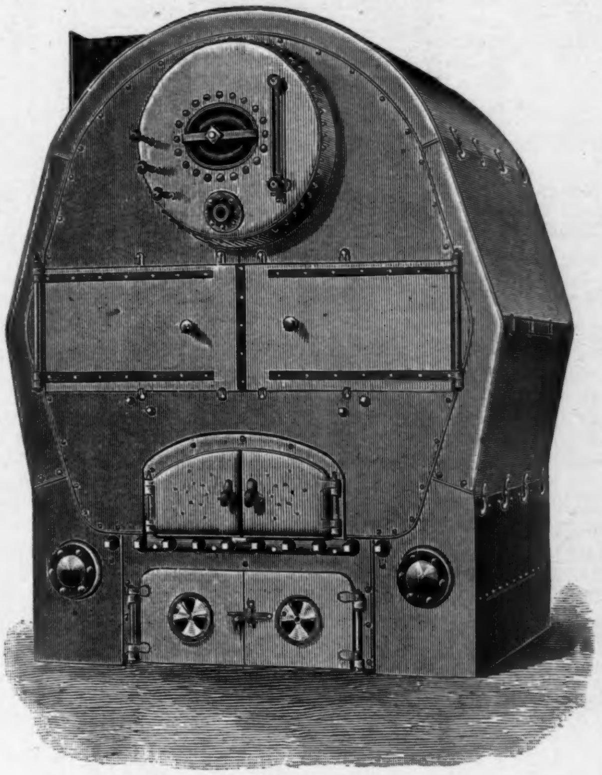


Fig. 1.

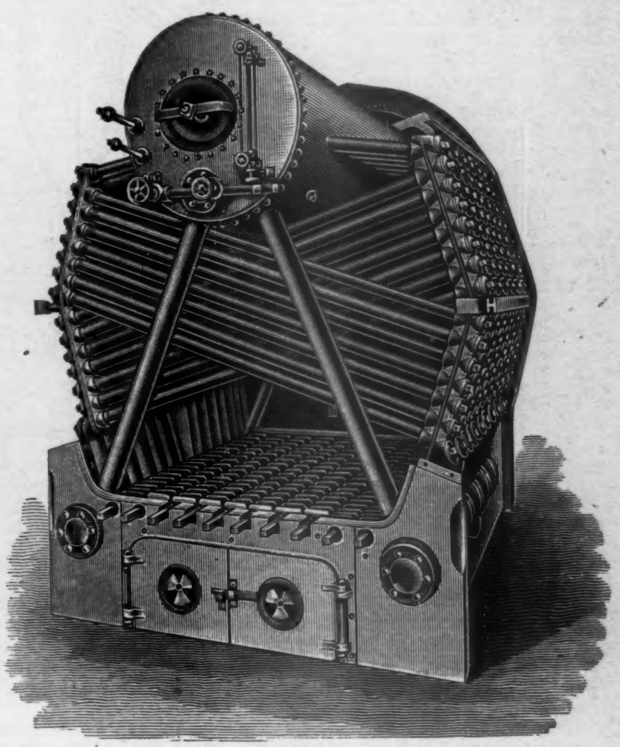


Fig. 2.

THE WORTHINGTON SAFETY WATER-TUBE BOILER.

The heating surfaces and waterways are so arranged that the movement of the water contained in the boiler is constant and rapid. Its course is as follows: From the steam-and-water drum located above the tubes, into which water is fed, it descends the water legs, four in number, placed outside the furnace, to the water-and-mud drums, at the base; thence it passes *viâ* the tube connections into the lower series of headers; thence through the tubes, over the fire, into the upper series of headers; thence *viâ* the tube connections into the steam and water drum again (from whence it started). The proportion and combination of parts throughout the boiler is such that expansion and contraction due to changing temperatures can occur without straining or disturbing the position of any part or system of parts.

The tubes being short, tubular expansion is reduced to a small fraction, as compared to that which is due to the employment of tubes of 16 to 20 ft. long.

The headers for tubes are made of steel or iron, according to the service required. They are placed closely together side by side, forming complete side walls to the furnace and affording a limited amount of effective heating surface.

Outside the furnace, opposite each end of each tube, a hand-hole of proper size to admit a tube or a tube expander is provided and fitted with a cap held to place with a cross-bar and bolt. This cap is accurately faced and ground to a perfect steam and water-tight joint. The caps are exposed upon opening the side doors, and can be examined or tightened if necessary. Upon removal of the cap, the internal condition of a tube is open to inspection, to cleaning, or, in case of leakage in the expanded joint, to re-expansion. And in case of accident to a tube or depreciation due to long usage, a new tube can be substituted with but little trouble and delay. Each end of each mud drum is provided with a removable cap accessible from outside.

The furnace is lined with fire-brick. The only other brick work required to erect a stationary boiler consists of two foundation walls of proper depth, rising above floor level about 12 in.

These boilers are proportioned and rated for generating power on the basis of the Centennial standard—namely, the evaporation of 30 lbs. of water, at 70 lbs. pressure, from temperature of 100°, to be 1 H.P. Said duty to be accomplished with a consumption of anthracite coal of good quality at the rate of 12 lbs. per hour per square foot of grate with good natural draft. It is claimed that the actual steaming efficiency and also the ultimate capacity are largely in excess of the rating on the above basis. A 100 H.P. boiler of this kind occupies a floor space 7½ ft. square, and is less than 10 ft. high.

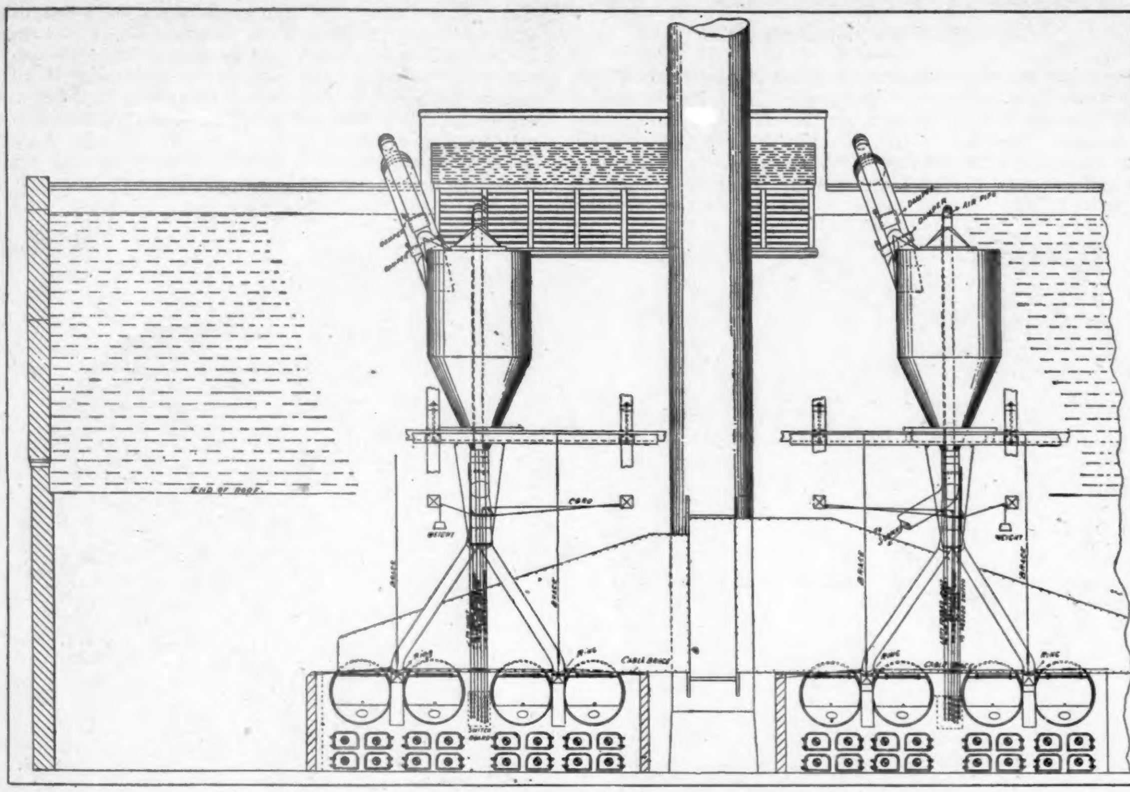
A Free Technical School.

In the educational department of the Young Men's Institute, of the Young Men's Christian Association of the City of New York, at 222 and 224 Bowery, much attention is given to technical studies, and the work is becoming more and more valuable to young mechanics and artisans. The evening classes in Electricity, Steam Engineering, Carriage Drafting, Mechanical Drawing, Freehand Drawing, Shorthand and Type-writing, Vocal Music, Arithmetic, Book-keeping and English Grammar have an enrollment of almost 300 young men. A free exhibition of work done in the classes was given on December 26, making an interesting showing of progress.

The Institute Committee of Management and the Carriage Builders' National Association award diplomas, prizes, and certificates of progress at the close of each class year.

An Appliance for Wood-Working Shops.

One of the problems requiring careful attention in a wood-working shop is the disposal of the sawdust, which would accumulate in large quantities if not carried off as it is made.



DUST-COLLECTOR AND FURNACE-FEEDER AT THE MADISON CAR WORKS.

An excellent method of meeting this problem is shown in the accompanying cut, which is from a drawing of a dust-collector and furnace feeder made by the United States Blow-Pipe Company, of Chicago, for the extensive car shops of the Madison Car Company, at Madison, Ill. The drawing shows the general arrangement of the shops and the apparatus.

The dust-collector and furnace-feeder itself, as shown, is the smallest part of the apparatus. The shop is equipped with galvanized steel piping and exhaust fans, by which the dust and shavings from the machines are collected and carried to the dust-collector, which feeds them directly to the boiler furnaces without the interposition of any manual labor whatever. Should more fuel be made than the furnaces can properly consume, a slight change will direct the surplus into a vault made for its reception, and in this way the fires can be regulated and choking of the furnaces avoided.

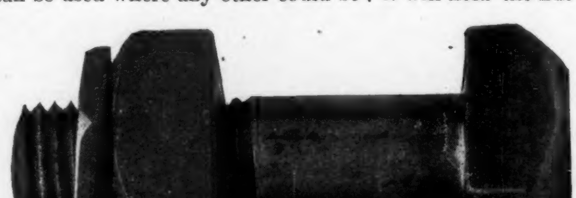
By experience with this apparatus, it is found that the regulation is an important point, giving an even and steady fire and keeping steam at any desired point. Economy in fuel is also secured, as well as a great saving in labor. In fact, the company claims that the cost of its apparatus in a large shop will be repaid in two or three years from the saving in labor alone. The apparatus has worked satisfactorily wherever tried.

The address of the United States Blow-Pipe Company is No. 16 South Canal Street, Chicago, and estimates can be furnished for fitting up shops of any size and capacity.

The Fougère Nut-Lock.

This nut-lock, which is shown in the accompanying illustration, is certainly simple in form and appears to have some excellent points. The lock is about the size of an ordinary washer, and is hexagonal in form. It is cut from a thin plate of mild steel proportioned in size and thickness to the bolt on which it is to be used. A thread is then cut in it obliquely, the angle of the lock nut to the cutting tool being from 3° to 8°, according to the size of the bolt. The lock-nut when screwed on the bolt assumes an oblique position thereto, so that when it is screwed down lightly until it reaches the nut or other resisting surface, one side bears and the other does not. If now it is forced with the wrench, the lock yields, and is gradually forced down squarely on the nut and lies flat on top of it. In this position it exerts a strong frictional contact with the top of the nut, and the thread in the lock being forced from its natural position, tends to cross the thread on the bolt, and the two threads thus grip each other. The lock is thus held by this grip and by the spring of the plate, forming a strong and positive lock. It is found by experience that the action of screwing up the lock does not injure the threads in any way. It has also been proved that the nut will not be loosened by vibration, nor can it be started by a wrench without first loosening the lock-nut.

Among the advantages claimed for this lock-nut are that it can be used where any other could be; it will hold the nut at



THE FOUGÈRE NUT-LOCK.

any point on the bolt, whether it is screwed up tight or not; it can be used again and again without injury to itself or the bolt, and it forms a neat finish.

This nut-lock is protected by patent No. 465,094, issued to Angus Fougère. Any information in relation to it can be obtained from R. H. Cushing, of Moncton, N. B.

Some 25,000 of the locks are in use on the Intercolonial Railway of Canada, where they have been thoroughly tested for over a year on track-bolts, locomotive tender frames and other positions.

Plans have been completed for a large depot to be built by the Baltimore & Ohio Company, at St. George, Staten Island. The plans were prepared by Baldwin & Pennington, who have made duplicate copies for the use of the railroad officials. Bids for this work will be asked for in a few days.

General Notes.

THE Safety Metallic Tie Company has been organized at Summit, N. J., with $500,000 capital stock, to make metallic ties and rail fastenings.

THE Pennsylvania Steel Refining Company has bought the old works of the Bates Steel Company, in Philadelphia, and will put them in operation, using the Reedman-Tilton process for refining and hardening steel. Mr. Walter J. Scott, late of New Albany, Ind., will be Superintendent.

THE Hyatt Roller Bearing Company has been organized in Newark, N. J., to make roller bearings for car journals and other purposes.

THE Gilbert Car Company, Troy, N. Y., has taken a contract to build 30 baggage cars, 10 combination cars, 20 smoking cars, 50 passengers cars and 20 passenger cars with vestibule ends for the New York Central & Hudson River Railroad.

THE Richmond Locomotive Works, Richmond, Va., recently completed an order of 30 freight engines for the Cleveland, Cincinnati, Chicago & St. Louis Railroad.

THE Weisel & Vietor Machine Company, whose works were destroyed in the recent great fire in Milwaukee, Wis., will rebuild them on a larger scale.

THE Schoen pressed steel brake-beam is to be used on 600 cars now building for the Duluth, Mesaba & Northern Railroad. These cars will also have Schoen pressed steel center-plates.

THE Roanoke Machine Works, Roanoke, Va., are building a number of locomotives for the Norfolk & Western Railroad.

THE shops of William Sellers & Company, Philadelphia, are building for the Massachusetts Institute of Technology a 300,000 lbs. Emery testing machine. This machine will be equipped with all the latest and most improved recording apparatus, and will have embodied in its construction some details that are not found in any other machines of its class. It is strictly a tensile machine, being horizontal, but compression tests could be made by the use of special appliances.

THE Frank-Kneeland Machine Company, recently organized in Pittsburgh with I. W. Frank as President and Edward Kneeland as Treasurer, is building a foundry and machine shop which will be thoroughly equipped with tools and machinery for doing the best work.

THE Stillwell-Bierce & Smith-Vaile Company, of Dayton, O., was recently formed by the consolidation of the Stillwell & Bierce and the Smith & Vaile companies. The new company is capitalized at $1,000,000, and $500,000 preferred stock offered for public subscription was promptly taken up. The company owns extensive works for the manufacture of turbines and other machinery.

THE offices of William C. Baker, the well-known manufacturer of car-heaters, has been removed to the Central Building, No. 143 Liberty Street, New York. Mr. Baker has established new works in Hoboken, N. J., which are fitted with the best appliances for manufacturing.

THE Akron Tool Company, Akron, O., has recently received orders for their McNeil patent balanced charging barrows from the Boston & Maine, the Georgia Southern & Florida and the Alabama Midland railroads. These barrows have found much favor in use at coaling stations on railroads, and are also in use at many gas works for handling hot coke and at blast furnaces for charging with coke and ore. Their use is rapidly extending.

THE Congdon Brake Shoe Company has established a plant for the manufacture of steel brake-shoes and couplers at 59th Street and Wallace Avenue, in Chicago. The works cover 2½ acres, and include a Siemens-Martin open-hearth steel plant with a capacity of 35 to 40 tons per day. Facilities are provided for making all kinds of steel castings here, as well as those required for the brake-shoe and coupler work, and arrangements have been made for turning out castings of a high grade, for locomotives and other machinery. Two large dynamos supply electricity for lighting the works and for running the Shaw electric cranes. These works will use oil for fuel; it is delivered in the works from the Pennsylvania Company's tracks.

AT a recent meeting of the directors of the Consolidated Car Heating Company, Albany, N. Y., a semi-annual dividend of 1½ per cent. was declared. The reports showed that the business of the company has averaged over $1,000 per day for some time past.

At the same meeting the offices of General Manager, Assistant General Manager and Mechanical Superintendent of the Company were abolished. Mr. D. D. Sewall, formerly General Manager, was appointed Vice-President; Mr. J. H. Sewall, former Assistant General Manager, with office in Chicago, was made Superintendent of Construction, with office in Albany; and Mr. J. F. McElroy, late Mechanical Superintendent, was appointed Consulting Engineer.

THE Walburn-Swenson Company, owning the Fort Scott Foundry & Machine Works at Fort Scott, Kan., is now removing the entire plant to Chicago Heights, as a more central and convenient location for its special business. The central office of the company has been established in the Monadnock Block.

THE Dietz Passenger Draw-Bar Company and the Dietz Freight Draw-Bar Company have been organized in Denver, Col., each with a capital stock of $500,000, to manufacture and introduce the Dietz draw-bars, which have been heretofore described in our columns. The officers of both companies are: President, Edward A. Reser; Vice-President and General Manager, Thomas C. Brainard; Secretary and Mechanical Expert, Henry Dietz; Treasurer, Henry B. Adsit.

THE largest single order for car-heating material ever given was received by the Consolidated Car-Heating Company, on December 15. This order was for the equipment of 100 New York Central standard coaches, which the Gilbert Car Manufacturing Company is building.

THE Schenectady Locomotive Works have received an order for 16 locomotives for the Chicago & Eastern Illinois, and three freight engines for the Maine Central. All are to be equipped with the New York air brakes.

THE Buffalo, Rochester & Pittsburgh Railroad is just receiving the last of the recent order for 850 cars, all equipped with the New York air brake.

THE Joseph Dixon Crucible Company, of Jersey City, manufacturers of Dixon's American Graphite pencils, are taking time by the forelock by putting a fifth story, 175 × 75 ft., on their pencil factory. During the past summer and fall they have been unable to promptly fill their orders for Dixon's pencils, even though working their already superior facilities to their full capacity. It was therefore decided to push forward the work at once instead of waiting until spring, as intended. The new addition will be equipped with new and improved pencil machinery of their own invention.

THE Lansberg Brake Company, St. Louis, recently received an order for 2,800 complete quick-action freight car brakes. The company's works are to be enlarged.

Forged Steel Balls.

THE Pittsburgh Steel Casting Company is now making steel balls by a special process, which is new and gives very good results. This company makes steel castings, and has lately found that cast-steel balls, forged, were susceptible of many industrial applications, and accordingly made preparations for their manufacture.

The balls are first cast as an ordinary casting, of a special crucible steel mixture, especially adapted for the purpose, which is somewhat more expensive than the mixture used for ordinary castings. The cast ball is brought to a forging heat in an ordinary heating furnace, and transferred to a 1-ton steam hammer, provided with hemispherical dies the size of the casting. While this hammer is rather heavy for the smaller-sized balls, its stroke can be made light enough to suit. The hammer being started at a rate of about 120 strokes per minute, the ball is dexterously rotated in different directions by the hammer-man, so that it is very evenly compressed, and all signs of the head and gate obliterated, a perfectly spherical ball being the result, while toward the latter end of the process a smooth polish may be seen to come. From time to time water is thrown on, and when the forging operation is completed, the ball is allowed to cool rapidly, so that the surface takes quite a good temper, and is excessively hard. The ball is compressed by about $\frac{1}{32}$ of its diameter.

These balls have probably not as yet been used for all the purposes for which they are adapted, but we are informed that they are used extensively for crushing purposes, for emery, black lead, corundum, rouge, etc. They are used also for ball bearings in turn-tables, etc.

Dies are provided for all sizes of balls, from 2 in. to 9 in. in diameter. The expense of forging, and of the extra mixture employed, makes these balls cost about 2 cents a pound more than an ordinary steel casting.—*American Manufacturer*

PERSONALS.

A. T. SHOEMAKER has removed his office in New York to the Boreel Building, No. 115 Broadway.

JOHN MEDWAY has been appointed Superintendent of Motive Power of the Fitchburg Railroad, with office in Boston, in place of O. STEWART, who has resigned.

DAVID POTTINGER, late General Superintendent of the Intercolonial, succeeds MR. COLLINGWOOD SCHRIEBER as Chief Engineer of Canadian Government railroads.

J. J. R. CROES delivered an interesting lecture on Passenger Traffic in Large Cities before the students of the Rensselaer Polytechnic Institute in Troy, N. Y., on November 30.

CAPTAIN ALFRED E. HUNT, President of the Pittsburgh Reduction Company, lectured on Aluminum recently before the students of the Rensselaer Polytechnic Institute.

W. I. COOK has been appointed Superintendent of Motive Power of the Toledo, St. Louis & Kansas City Railroad, in place of JOHN ORTTON, who has resigned on account of continued ill health.

HUNTER MCDONALD, for some time past in charge of the construction of new branches, has been appointed Chief Engineer of the Nashville, Chattanooga & St. Louis Railroad, to succeed the late COLONEL R. C. MORRIS.

HENRY A. MILLHOLLAND, formerly with the Pennsylvania Railroad, and more recently Mechanical Engineer of the Gould Coupler Company, has been appointed Assistant to the Superintendent of Motive Power of the Philadelphia & Reading Railroad.

F. W. SARGENT, formerly Engineer of Tests of the Chicago, Burlington & Quincy Railroad and recently General Agent of the Congdon Brake Shoe Company of Chicago, has been appointed Superintendent in charge of that company's manufacturing department.

JACOB JOHANN has been appointed Superintendent of Motive Power of the Chicago & Alton Railroad, with office in Bloomington, Ill., in place of A. W. QUACKENBUSH, resigned. Mr. Johann is well known as a master mechanic of long experience, who has had charge of the machinery of some important roads.

THEODORE VOORHEES, General Superintendent of the New York Central & Hudson River Railroad, delivered a lecture on Transportation before the students of the Rensselaer Polytechnic Institute at Troy, N. Y., December 7. Mr. Voorhees is a graduate of the Institute, and is also a member of its Board of Trustees.

THE friends of MR. JOHN ORTTON will be grieved to hear of his serious illness. For a long time he has been in poor health, but recently he has been a great sufferer, although the latest accounts report his condition somewhat more favorable for recovery. He is now at Frankfort, Ind., having resigned his position as Superintendent of Machinery on the Toledo, St. Louis & Kansas City Railroad.

AUGUSTUS MORDECAI, who succeeds MR. C. W. BUCHHOLZ as Chief Engineer of the New York, Lake Erie & Western Railroad, has been since 1888 General Roadmaster of the New York, Pennsylvania & Ohio. He had previously served as Division Engineer on that road, and also on the Pittsburgh, Virginia & Charleston, the St. Louis, Council Bluffs & Omaha, the Hartford & Connecticut Western and the Pennsylvania Railroad.

OBITUARIES.

JOSEPH N. DUBARRY, who died in Philadelphia, December 17, aged 62 years, was born in Bordentown, N. J., and when 18 years old was employed on one of the engineer corps engaged in locating the Pennsylvania Railroad from Altoona to Pittsburgh. In 1850 he was made Assistant Engineer of Construction, and in 1852 had charge of surveys on the old Sunbury & Erie Railroad. In 1853 he was made Principal Assistant Engineer of the Southwest Branch of the Pacific Railroad of Missouri, and remained on that line five years, when he returned East as Superintendent and Engineer of the Western Division of the Pittsburgh, Fort Wayne & Chicago. In 1861 he became General Superintendent of the Northern Central Railroad, where he remained until 1867, when he was appointed to the position of Assistant to the President of the Pennsylvania Railroad Company, which he filled with marked ability until October, 1882, when he was made Third Vice-President. His duties then were those of General Supervisor of Constructions, having charge of the construction of new lines, of bridges, viaducts, tunnels, of straightening curves, and the determination of all engineering questions. In 1888 Mr. DuBarry was elected Second Vice-President to take the place of Mr. Frank Thomson, who had been elected First Vice-President, and he occupied that important office in the company's affairs up to the time of his death. In this capacity his duties embraced a general supervision of all financial affairs and a direct oversight of the treasury and insurance departments. He was also the master mind in the promotion and construction of new lines of road and the maintenance of the old lines to the highest standard.

PROFESSOR JOHN STOREY NEWBERRY, who died in New Haven, Conn., December 7, aged 70 years, was born in Windsor, Conn., but at an early age was taken to Ohio by his parents. He graduated from the Western Reserve College in 1846, and from the Cleveland Medical College in 1848. He spent two years traveling and studying in Europe and then addressed himself to the practice of medicine in Cleveland. In 1855 he joined the Army, and was sent with a Government expedition for exploring the region between San Francisco and the Columbian River. This region turned his attention to those sciences which became his life study, and the impulse toward them was further developed by the Ives expedition along the Colorado River in 1857–58. In 1859 he aided in exploring the San Juan and upper Columbia. During the war he was a member of the United States Sanitary Commission for the Mississippi Valley, and made inspections and distributed stores and means of shelter. In 1866 he became Professor of Geology in the Columbia School of Mines, and the development of the department of geology has been his chief work. He has collected the most extensive geological museum in the country, its specimens and exhibits numbering over 1,000,000 separate pieces. While actively engaged in the work of his professorship, he also, in 1869, reorganized and directed the Ohio Geological Survey. After this he took part in the New Jersey Geological Survey, was made Paleontologist to the United States Geological Survey, was a judge in the Centennial Exposition, was a corporate member of the National Academy of Science under appointment from Congress. He became President of the New York Academy of Sciences in 1867 and afterward of the Torrey Botanical Society. For a quarter of a century his opinion upon geological and mineralogical matters has been most highly esteemed and his services were frequently sought as a mining engineer. He had a stroke of paralysis in December, 1890, and was obliged to give up active work.

DR. WERNER SIEMENS, who died in Berlin, Germany, December 6, aged 76 years, was himself an eminent electrician, and was one of a prominent family. To his brother, the late Sir William Siemens, we owe the open-hearth steel process, and Sir William and Frederick, another brother, were the inventors of the regenerative gas furnace. The invention of the dynamo in its present form is a matter of dispute, but the honor of being the first to make a commercial machine belongs without doubt to Werner Siemens. He commenced life in the German Army. While holding his commission he invented the process of electro-gilding, of the differential governor and of the electric automatic recording telegraph. As member of a commission of the Prussian General Staff for the introduction of the electric telegraph system in place of optical telegraphs, he proposed in 1847 the application of subterranean conductors insulated by gutta percha, by means of a press invented by him for that purpose, which is still being used in the manufacture of cables. With the help of these insulated wires he succeeded in the spring of 1848, together with Professor Himly, in laying the first submarine mines with electric ignition for the protection of the harbor of Kiel from the Danish fleet. In the same year he carried out the first great telegraph line in Germany between Berlin and Frankfort-on-the-Main, and in the following year the subterranean line between Berlin and Cologne. Dr. Siemens left the government service in 1850, and devoted himself afterward entirely to scientific studies and to private enterprises. In 1847 he had already laid the foundation of the telegraph works afterward carried on by him under the firm of Siemens & Halske, in Berlin. Among his many achievements in science and the technical arts may be mentioned the invention and practical application of the quicksilver resistance unit, the gutta percha press, the development of methods for testing underground and submarine cables, and determining the position of faults in them; the invention of polarized relays, and the Siemens armature.

PROCEEDINGS OF SOCIETIES.

American Society of Civil Engineers.—At the regular meeting, December 7, there was a long discussion on Mr. James D. Schuyler's paper on Asphaltum Lining for Reservoirs. Mr. W. B. Parsons read a paper on Recent Test Borings on Broadway, which was discussed.

The following elections were announced:

Members: William H. Brown, Philadelphia; Howard Constable, New York; John N. Chester, New Rochelle, N. Y.; Loring G. Goddard, Dunham, O.; George S. Hayes, East Berlin, Conn.; Edmund G. Spilsbury, Trenton, N. J.

Associate Members: Edward T. McConnell, Indianapolis, Ind.; Henry F. Baldwin, Chicago.

American Society of Mechanical Engineers.—The meeting which began in New York, November 29, was a successful one, both in the large attendance and in the number of papers presented. Some of the latter were of much value, but the discussions were not as full or as general as at some previous meetings. Exceptions must be made, however, for two or three of the topical discussions, which called out some practical experiences worth noting.

The Society is in a prosperous condition, with a cash balance in the Treasury. It numbers now 1,569 members, and 94 new ones were added at the meeting.

American Institute of Mining Engineers.—The 64th meeting will be held in Montreal, beginning on February 21.

It is announced that the members of the Institute have subscribed $4,000, or its full share, to the fund for the expenses of the Engineering Congress in Chicago.

Roadmasters' Association of America.—At the annual meeting very full reports were presented on Rail-joints, recommending the Fisher, the Long, and the McConway & Torley joints for further trial; on Methods of Fastening Rails to Ties; on Work Trains; on Block Signaling; on Treating Ties, and on Relaying Rails. All these reports were thoroughly discussed by the members, a large number being present.

The officers elected were: President, H. W. Reed; Vice-Presidents, W. H. Stearns and J. B. Moll; Secretary and Treasurer, J. H. K. Burgwin; Member Executive Committee, Robert Black.

It was decided to hold the next annual meeting in Chicago.

American Society of Naval Architects & Marine Engineers.—Some of the most prominent and influential men in the shipbuilding and shipping interests of the United States have completed the preliminary organization of a professional society of high standing to be called by this name, whose object will be to promote the art of shipbuilding in all its branches, both commercial and naval. The Committee of Organization—consisting of William H. Webb, of New York; Lewis Nixon, of Philadelphia; Colonel E. A. Stevens, of Hoboken; Francis T. Bowles, Naval Constructor, U. S. N., and Clement A. Griscom, President of the International Navigation Company—expect to incorporate the Society in New York, and are now sending out invitations to membership, hoping to have the first meeting at the time of the Naval Review.

The list of those who have accepted positions in the preliminary organization include many well-known names from all sections of the country: President, Clement A. Griscom; Vice-Presidents, T. D. Wilson, Chief Constructor of the Navy; Charles H. Cramp; George W. Melville, Engineer-in-Chief U. S. N.; George W. Quintard, New York; Irving M Scott, San Francisco; General Francis A. Walker, Boston; W. H. Webb, New York. The members of the council include H. T, Gause, Wilmington, Del.; F. W. Wheeler, West Bay City; Mich.; W. H. Jaques; General T. W. Hyde, Bath, Me.. J. W. Miller, New York; C. H. Orcutt, Newport News, Va.; Nat. G. Herreshoff; J. F. Pankhurst, Cleveland, O.; Naval Constructors Hichborn and Fernald, of the Navy; Charles H. Loring, ex-Engineer-in-Chief; Commanders Chadwick and Sampson, of the Navy; Harrington Putnam, of New York. Assistant Naval Constructor W. D. Capps is Secretary and Treasurer.

In consideration of the increasing importance of our shipbuilding interests and the development of the Navy, the organization of this Society upon a basis similar to that of the civil engineers and kindred professions is regarded as opportune and having a valuable and extended field of influence in technical subjects and public affairs.

Traveling Engineers' Association.—At a meeting held in Chicago, November 12, a call was agreed on and issued. It is signed by C. B. Conger, Chairman, and a number of others from different roads:

"We, the undersigned road foremen of engines, or traveling engineers, consider that an association of men in our calling would be beneficial in that an exchange of ideas would tend to uniformity in our work and to widening our information and usefulness, and, if properly conducted, would make the position of traveling engineer recognized as one of great usefulness to railroads and to enginemen. It would prevent friction by promptly rectifying small abuses; prevent waste by conducting a practical education and the encouragement of economical practices.

"We ask all traveling engineers and road foremen of engines to meet for the purpose of organizing an association similar to the Master Mechanics' Association, said meeting to be held at 2 P.M. Monday, January 9, 1893, at Room 912, No. 5 Beekman Street, New York City, office of *Locomotive Engineering*. If this meets with your approval, will you kindly correspond with John A. Hill, at above address, at your earliest convenience, stating if you will be present, or if not if you will join the association."

New York Railroad Club.—At the regular meeting, December 15, Mr. Alonzo Dolbeer read a paper on When Should a Locomotive be Destroyed? This was generally discussed.

Topical questions proposed for discussion were the difference in cost of Operating and Maintaining Locomotives in Freight Service at high and low speeds; and the use of Plain or Flangeless Tires. The attendance at the meeting was large.

Master Mechanics' Association.—Secretary Sinclair has sent out the following circular from the Committee on Boiler Attachments, consisting of James Macbeth, A. Dolbeer, W. A. Foster, James M. Boon and M. N. Forney. Replies should be sent to the Chairman, Mr. Macbeth, at Herkimer, N. Y.

BOILER ATTACHMENTS.

Among the subjects selected at the last annual convention of the American Railway Master Mechanics' Association for investigation by committees, and to be reported at the next meeting of the Association, is Boiler Attachments; how can the safety of these be increased, and how the number of holes in boiler for such attachments be lessened.

The undersigned have been appointed a committee to conduct this investigation and make a report thereon next year. With this end in view the Committee ask for information with reference thereto.

It is a well-known fact that in cases of collision or derailment a very common cause of accident to locomotive runners, firemen, and others, is that some of the boiler attachments are broken so as to leave an opening in the boiler from which steam or hot water escapes and scalds whoever may be fastened in the wreck. The aim of the Committee is to institute an inquiry to ascertain what can be done to prevent such accidents, or at least diminish their number, and with this end in view they ask for information concerning the following points:

First: Give a list of parts attached to your standard locomotive boiler which, if broken off in case of accident, would leave openings in the boiler.

Second: How could the number of openings in boilers for such attachments be diminished?

Third: In what way could such openings be protected to prevent escape of hot water or steam in case attachments are accidently broken?

Fourth: What is the best method of connecting check valves to boilers, flange joints or screwed direct into boiler. Give size of connection that should be used. Have you had any experience with inside check valves, and what is your opinion of their safety and efficiency compared with outside checks?

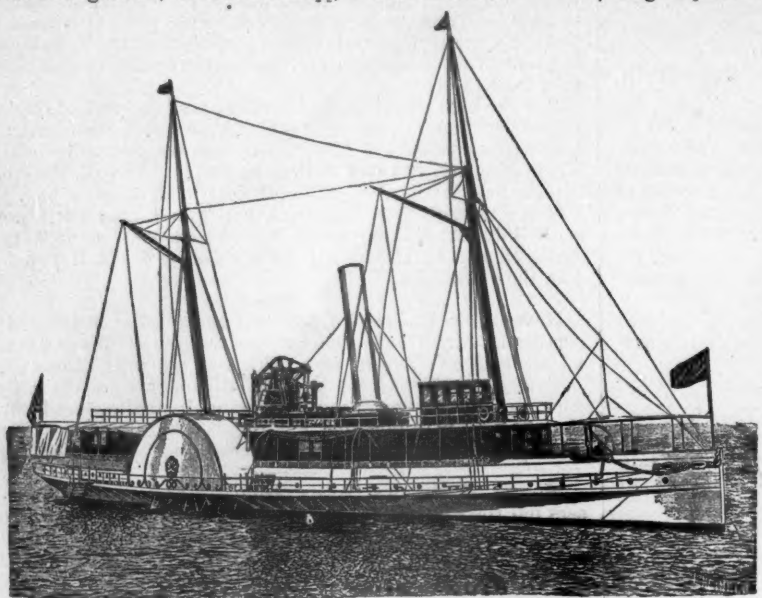
Fifth: Water Glass and Gauge Cocks.—Do you think it necessary or advisable to use water glasses in addition to gauge cocks? What size connection do you use? Is it advisable to use an automatic valve in water glass cocks to prevent the blow of steam and hot water in case of water glass breaking?

Sixth: Steam Chambers.—Is it your practice to use a steam chamber to connect the blower, injector valves, steam heating valves, etc., or is it your practice to connect these attachments separately to boiler? Is any provision made to close the connection between steam chamber and boiler?

The Committee would be glad if replies are not confined to the questions, but extended to any information bearing on the subject. Would also be pleased to have drawings and blue prints of any devices used on your line.

NOTES AND NEWS.

A Side-Wheel Yacht.—The illustration given herewith, for which we are indebted to the *Engineer*, of New York, shows the yacht *Clermont*, which differs from most of the steam yachts along the coast in having paddle wheels instead of a propeller. The *Clermont* has a wooden hull 160 ft. 3 in. long over all; 150 ft. 6 in. on load line; 25 ft. molded beam; 43 ft. over guards; 10 ft. 8 in. deep; 5 ft. 3 in. draft.



SIDE-WHEEL STEAM YACHT "CLERMONT."

The engine, which was built by the W. & A. Fletcher Company, New York, is of the beam type, with cylinder 40 in. in diameter and 6 ft. stroke; the wheels are of the feathering pattern, 17 ft. in diameter and 6 ft. 6 in. face. There is one steel return-flue boiler 8 ft. 1 in. in diameter and 26 ft. long; the usual working pressure is 60 lbs. There is also a donkey boiler carrying 125 lbs.; a steam windlass and other fittings. The boat is lighted by electricity, the dynamo being driven by an engine with 5 × 6 in. cylinder.

The actual speed of the *Clermont* in dead water is 18 miles an hour with 46 revolutions per minute. At this speed the engine develops about 800 H.P. She was built for cruising and not for speed.

The *Clermont* is handsomely fitted up and has plenty of accommodations for passengers and crew. The advantages of the side-wheel type are speed on a light draft, quiet running with absence of vibration, and plenty of room.

A Geometric Boring Tool.—An ingenious device for boring holes of square, hexagon, star-shaped and other geometric sections is now being introduced by the Geometric Drill Company, of Philadelphia. It is in the form of an attachment which can be put on an ordinary drill press, and can be fitted to bore any shape of hole having straight or curved sides. While it would be difficult to describe this tool without illustrations, it may be said that it is quite simple. The movement of the boring tool is controlled by a cam, and it can be quickly adjusted to bore the shape desired.

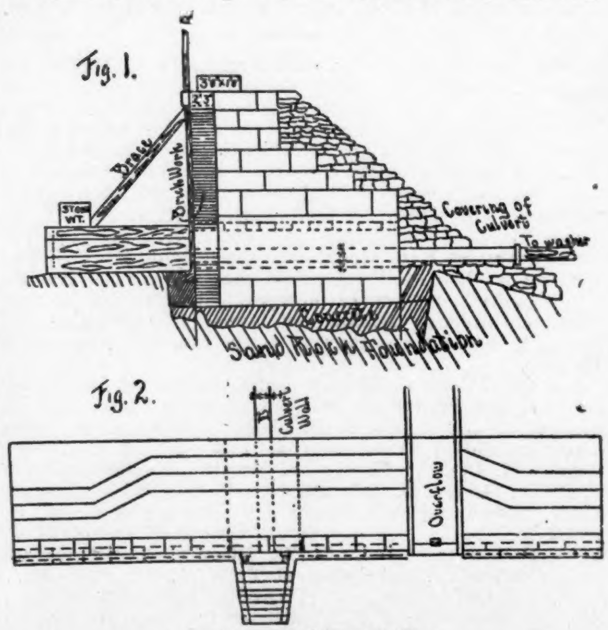
A recent inspection of this tool in operation showed some excellent work and a great variety of shapes. It can be used to bore simple round holes as well as other shapes.

An American-English Screw Factory.—The London *Engineering Record* says: "The new screw-making establishment, which has been built on the site of what were known as Whitham's Ironworks, at Leeds, and which is owned and conducted by the American Screw Company, of Providence, R. I., U. S., under the title of the British Screw Company, Limited, chartered under the laws of Great Britain, is being developed as rapidly as possible. The ground on which the works stand has an area of about five acres. The structure is 360 ft. in length, and has a frontage of 100 ft. The machinery is driven by a compound triple-expansion engine of 350 H.P., made by Messrs. Woodhouse & Mitchell, of Brighouse; the boilers, of 400 H.P. capacity, are from the works of Messrs. Babcock & Wilcox, Limited, Glasgow, and they have attached to them mechanical stokers. The factory is lighted by electricity, there being throughout it 500 incandescent lamps, and 45 arc lamps of 2,000 candle-power. The screw-making machinery has come from Providence. It has been running a couple of months, and at present about 12,000 gross of screws, of many different sizes, are being turned out per week. The heads of the different departments have also come from the home works in Rhode Island, but it is intended that they shall only remain here until English workers have been educated to fill their positions. It is, in fact, to be a thoroughly English manufactory so far as the workpeople are concerned. About 100, chiefly women and girls, have already found employment in the works, and it is expected that within a year from now some 500 or 600 will be at work."

A Simple Dam.—In many ore regions of the country the supply of water is by no means plentiful at any time, while at certain periods it fails almost altogether. As water is a prime necessity for washing the ore and for other purposes, an abundant and constant supply of water becomes a great desideratum, and in many places dams need to be constructed. A very simple dam, which can be easily constructed, is shown in the illustration on this page. It was built by the Rich Patch Iron Company, Low Moor, Va., and is the second dam of this company, which now has an abundant supply of water. A ground plan is shown, also vertical section.

The dam is 85 ft. wide, with an average depth of 11 ft. It is built of masonry embedded 4 ft. in the solid rock, and has a brick facing 18 in. thick on the water side. In both this dam and the one previously constructed by the company, the water is taken from the bottom, and this is considered quite an advantage. It passes through the dam by a 10-in. pipe, which is laid through the dam wall in a culvert. This is done to insure safety, and to avoid tearing out the masonry should any accident happen to the pipe. The pipe is bricked in between the walls of the culvert.

A protection has been provided extending 10 ft. from the face of the wall, which is designed to prevent any obstruction interfering with raising the gate. It consists of three 12 × 12-in. timbers bolted together, with two cross-ties at each end.



THE RICH PATCH DAM.

In the smaller and upper end have been inserted ten 2-in. iron bars 1 in. apart, to allow the water to go through. This protection is covered over and weighted down at its up-stream end, and also braced against the upright guides for the gate. The dam is also provided with two overflow gates 3 ft. wide and 3 ft. 6 in. high each, to be used in case of heavy floods.

The Rich Patch Iron Company informs us that the dams work excellently, and that it has been washing, with one Copeland & Bacon washer, 220 tons of ore per day from one dam. —*American Manufacturer*.